MESG

MESTRADO EM ENGENHARIA DE SERVIÇOS E GESTÃO

Designing a Product Service System in the Context of Social Internet of Things

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Dissertação de Mestrado

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To my Parents and Brother

Abstract

Technology has already taken its toll on human life and is present everwhere. Nowadays many companies are moving towards the internet as a source of doing business. Indeed, major cities are embarked on smart cities projects whereby everything will be connected together. Social media has evolved from the traditional 'keeping touch with family and friends' to a platform whereby businesses are advertised, game developer shows their talent and much more. Indeed, there is a need to see how social relationship can be translated to objects and a new paradigm, namely the Social Internet of Things try to address this transition.

This research aims to design a product service system under the context of the social internet of things using a real case study of a smart social bike. The research uses the design science research methodology nested in the design thinking approach to integrate concept of product service system into the multi-level service design. New service concepts are proposed and an architecture is designed for the operationability of the service based on the Social Internet of Things paradigm. Also, this research aim to show how service design methods can be applied in the context of product service system and social internet of things.

Keywords: *Product Service Systems, Service Design, Smart Services, Social Internet of things*

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1 Introduction

Nowadays, there is a growing shifts towards services which raises the challenge of properly designing services. Service design is a systematic process based on a human centred approach (Evenson S 2006) and is crucial to service innovation. Service design is a rapidly evolving interdisciplinary field that synthesizes service science and design thinking, integrating contributions from services marketing, interaction design, operations management and information systems to design service offerings that enable customers to co-create valuable experiences (Patrício et al. 2013). Indeed, advances in technology has changed the way services and products are designed.

Service delivery and experience has been revolutionised through the advances of the technology that have changed the customer life cycle (Ostrom et al. 2015). There are more opportunities for better quality and personalised services as well as profound customer relationship due to the rise of information technology such as Internet of Things, social network technology, mobile technology and cloud computing. These technologies permit the omnipresent customer communication and acquisition, storage and analysis of big data (Rust and Huang 2014). Big Data can be defined as the huge set of information being generated in real time and coming from a different sources and types(McAfee et al. 2012). The evolution of cutting-edge technologies has helped companies to improve service offering as they look to service as a differentiating factor that promote growth (Ostrom et al. 2015).

Information Technology has remodelled products. Products are now more complex including hardware, sensors, data storage, microprocessors, software, and connectivity, they are more than just an object comprising of mechanical and electrical parts. An amalgam of ubiquitous wireless connectivity, advancement in processing power and device miniaturization has been the pillar for the so called ‘smart, connected products’. (Porter and Heppelmann 2014).

One advancement in technology has been the Internet of Things. The internet of things is defined as the ‘interconnection of sensing and actuating devices providing the ability to share information across platforms through a unified framework, developing a common operating picture for enabling innovative applications. This is achieved by seamless ubiquitous sensing, data analytics and information representation with Cloud computing as the unifying framework’(Gubbi et al. 2013). The maturity and adoption of technologies and their relevancy in providing solution to real life problems is given by Gartner Hype Cycles. According to this cycle, IOT has been predicted to take around 5-10 years for market adoption(Gubbi et al. 2013). The graph (Figure 1) raises the concern of properly addressing services that will function under the IOT so as to adapt well to the market.

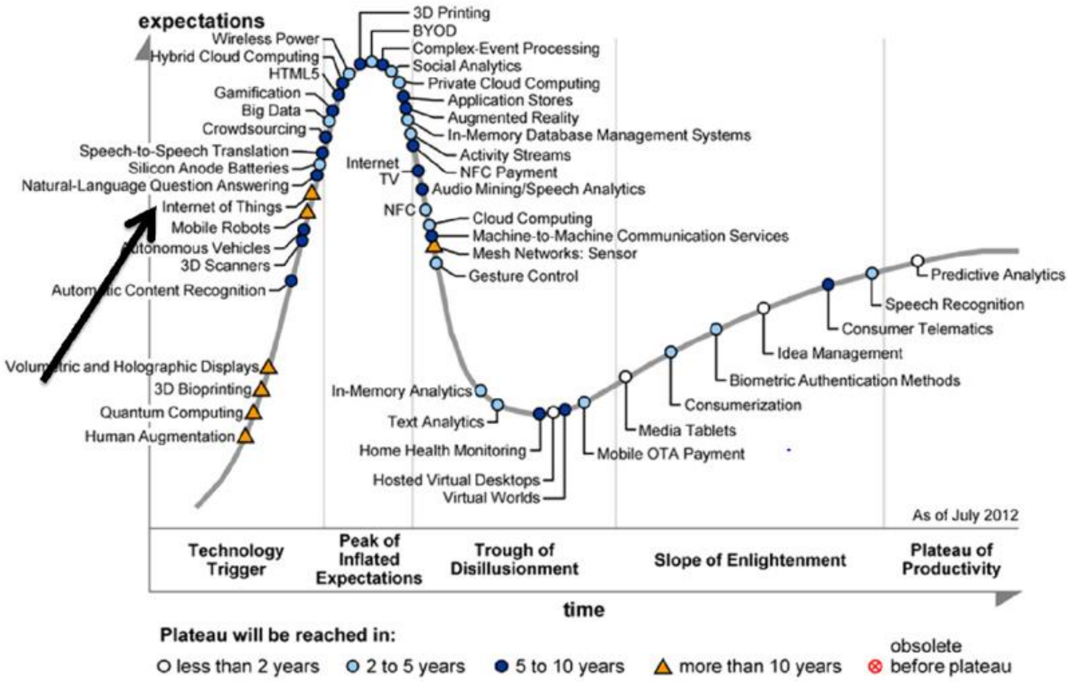

Figure 1 Gartner 2012 Hype Cycle of Emerging Technologies.

Source: Gartner Inc

Some research has been performed with the aim of integrating social networking concepts in IOT. Atzori et al., 2011 propose the construction of a social network, ‘Social Internet of things’, that they argued will provide a navigable structure to the Internet Of Things market. The paradigm makes use of social relationships between objects for service discovery(Atzori, Iera, and Morabito 2011).

The aforestated scenario prompts this research that encompasses the area of Product Service System and Social Internet of Things within a Service Design Approach.

1.1 Research Project

The research project was propounded by CEIIA (Centro para a Excelência e Inovação na Indústria Automóvel), an innovative and engineering centre based in Matosinhos, Portugal. The aim of CEIIA is to enhance the competitiveness of mobility through international cooperation between university and industry in market oriented product and solutions. CEIIA’s core activity focuses on intelligent mobility systems and devices requiring an examination of the potential of a system whereby users, devices, infrastructure and systems interact dynamically in a so called ‘social network’. For CEIIA, an intelligent and social bike is a test bed, case study that the company wish to implement on its mobility platform Mobi.ME.

1.2 Research Objectives and Questions

The objectives of the thesis are in twofold, practical and research. The practical objectives are to develop a service for the future generation of bike sharing that will allow bikes to connect to each other as a social network by sharing information using the ‘Social Internet of Things Paradigm’. The new service should be developed in such a way that it can be used in other mobility project such as the electric car sharing. Also, the service should provide an interoperable ecosystem whereby accessibility and usage for private bike is easy. Practical objectives that focuses on developing a set of services to make the so called ‘Social Bike Sharing’ works and fits the strategic plan of CEIIA identified are:

1. Definition of an architecture and requirements of a bike- sharing service system on the principle of the social internet of things.
2. Definition of a typology of services associated with the bike- sharing system.
3. Development of value proposition and business model associated.
4. Identification of use cases around the designed system.

A research objective for the project relates to the integration of Product Service System concept in the service design process. The research aims to create a smart service in the context of the Social Internet of Things Paradigm by integrating concept from Product Service System and Service Design. The research questions identified are:

1. How to integrate the concept of PSS in the design of the new service for the smart social bike under the ‘Social Internet of Things Paradigm’?
2. How to design an architecture to support such new Product Service System?

1.3 Outline

The thesis is structured in nine chapters. Chapter two presents the fundamental topics that help address the research. The topics are Smart Services, Product Service Systems, Internet of Things and Social Internet of Things. Chapter three describes the methodology used in the conceptualisation of a new service following a Design Science Research Methodology and the New Service Development approach. Chapter four presents the analysis of the results obtained in the qualitative and quantitative survey. Also, the requirements derived from the study are presented. Chapter five deals with the ideation phase whereby the new concept is proposed. Chapter six illustrates the design of a system architecture that will support the functioning of the concept proposed. Chapter seven illustrates the conclusion and future works.

2 Literature Review

To be able to answer the research questions, the first step is to undertake a literature review on important topics pertaining to the project. The topics identified are smart services, product service system, internet of things and social internet of things. These topics are explained in details in the following section. The aim of the project comprise of connecting the bike together to share information which goes in line with the project of smart cities and internet of things. Internet of things being a new concept, it is important to understand the concept and the impact it has on new business models. Since the idea is to have a bike as a social object, the concept of social internet of things is reviewed. Nowadays, there is a major shift towards services and a Product Service System (PSS) lays a strong emphasis on environmental and social gains. In the current context the usefulness of a PSS is good to explore as a bike is a mean to contribute to a greener society and reduce carbon footprints.

2.1 Smart Services

Smart services can be defined as a service conveyed through the use of intelligent products that possess some kind of awareness and connectivity (Allmendinger 2005). Such services include pre-emptive services, such as remote monitoring of intelligent machines (Biehl 2004), self-services, such as information services made available for the customer through Internet access via car electronics (Lenfle 2009), or highly interactive services, such as collaborative remote repair of machines or remote surgeries with collaborating physicians at distant locations (Sila 2001). An intelligent product are those that 'contain information technology (IT) in the form of microchips, software, and sensors and provide companies with the means to collect, process, and produce information to serve customers and provide solutions in many domains' (Rijsdijk 2007). It has been argued that smart services help boost business to business and business to consumer settings such as mechanical engineering, health care, information and communication technology (ICT), automotive, and household appliances (Fano 2002). According to Habor Research 2010 the forecasted investment into smart objects in 2014 is US$350 billion and Dutta 2009 further argue that smart service-enabled objects in companies' serviceable assets has increased to 27.9% in 2009. Others argued that the application of smart services foresee a consequent increase in efficiency for the providers and users in terms of cost reductions, increased flexibility, increased access and time savings (Allmendinger 2005). Biehl, Prater and McIntyre 2004, argue that to gain customer acceptance and usage of new innovative services is a big challenge despite the rapid emergence of smart services (Biehl 2004). Keh and Pang (2010) argue that customers perceive technology-mediated services as risky (Keh 2010). 'As these perceptions influence customers buying decisions, smart service providers need to overcome these obstacles to raise user acceptance of smart service innovations' (Wünderlich, Wangenheim, and Bitner 2013). They further points out that 'some smart services are delivered object-to-object with no human contribution whatsoever, others involve customers and employees as integral participants' (Wünderlich, Wangenheim, and Bitner 2013). 'The defining characteristic of smart services is the delivery to or through intelligent products or connected objects.' 'Smart services form a heterogeneous group of services that exhibit different levels of customer interactivity involved in the service delivery' (Wünderlich, Wangenheim, and Bitner 2013).

2.2 Product Service System

Mont defines the product service systems as "a marketable set of products and services capable of jointly fulfilling a user's need.(Mont 2002). Concepts and tendencies of PSS are:

- The usage of the product instead of the product itself
- The shift to a 'leasing society'
- The replacement of products by service machines
- A repair-society instead of a throw-away society
- The shift of consumer behaviour towards a more service orientations

One important aim of using PSS is to reduce environmental impact by:

- Winding up material cycles
- Decrease usage of product through alternative scenario
- Maximise resource productivity and dematerialise PSS
- Providing solution that allow easy integration and ensure efficiency of systems elements.

Companies using a product service system gain competitive advantage by modifying the traditional usage of their product by adding a service element to it. Moreover, increasing profitability by proposing alternative scenario of usage is another aim of PSS as it seeks to create a balance between economic, social and environmental issues (Beuren, Gomes Ferreira, and Cauchick Miguel 2013).

PSS comprise of the following elements:

1. the product
2. the service
3. the combination of products, services and their relationships

Manzini and Vezzoli argued that 'the PSS is a strategic design intended to integrate a system of products, services and communication based on new forms of organization, role reconfiguration, customers and other stakeholders' (Manzini and Vezzoli 2003). "Strategic design for sustainability" stands for the ability to create new stakeholder configurations and develop an integrated system of products, services and communication that is coherent with the medium-long-term perspective of sustainability (Beuren, Gomes Ferreira, and Cauchick Miguel 2013).

According to Morelli, a PSS is a social construction whose foundation are goals, expected results and problem-solving criteria that stimulate the involvement of different partners. Such participation creates a value co-production process whose efficiency depends on a shared vision of possible and desirable scenarios. (Morelli 2006a).

There are three perspective to a PSS and these are:

1. Product oriented PSS:

In this model, the proprietary right of the artefact is conveyed to the users. A service is offered to ensure usefulness of the artefact. Examples are warranties and maintenance contracts. The service increase the lifetime of the product thereby improving resource productivity.(Cook, Bhamra, and Lemon 2006) .

2. Use oriented PSS:

The ownership rights stays with the service provider and the user buy use of the product for a given time. Example are warrantees and maintenance contracts. High usage of these systems increase resource productivity as in the example of a mobility schemes require fewer cars per kilometre travelled per person (Cook, Bhamra, and Lemon 2006).

3. Result oriented PSS:

In this model, proprietary rights stays with service provider and the user buys the utility as an outcome for a given time. An example is the leasing of a washing machine, the customer buys clean clothes obtained from the washing service. The supplier owned the product and are paid per unit of service delivered. Thus they received an economic interest that create opportunities to improve environmental performance (Cook, Bhamra, and Lemon 2006).

The PSS must be planned at a systemic level, as previously identified(Lee and AbuAli 2011). Continuous adjustment and improvement to the user demand and requirements are needed for the plan. The adjustment can be performed as follows:

1. Involving consumer in idea generation to promote innovation.
2. Promote participation of user to get relevant feedback.

(Beuren, Gomes Ferreira, and Cauchick Miguel 2013).

2.3 Internet of things

The internet of things (IOT), can be defined as the connection of physical objects in a network by using embedded sensors, actuators and other devices that gather information on objects scattered in the environment. The huge volume of data are processed and analysed into meaningful information to enhance products, services and operations. One example is the usage of sensor to monitor pattern of electric consumption and to vary the distribution according to the demand. (Harald Bauer December 2014).

According to Chui et al. 2010, the internet of things will help create new profitable business models. Objects that communicate and sense the environment becomes tools for understanding complexity and respond to it. One famous use of IOT is to track RFID on products along the supply chain thereby optimizing the inventory while reducing working capital and logistics cost. According to Chui et al.2010, IOT can be classified into two main components: information & analysis and automation & control. The information and analysis part consists of tracking behaviour, enhancing situational analysis and sensor driven decision analytics. The automation and control part comprises of process optimization, resource consumption optimization and complex autonomous systems. Approximately 50 billion devices will be linked to the internet worldwide by 2020. Burkitt 2014 argues that one third of these device will be traditional one such as computers, smartphones, tablets and TVs while the rest will be sensors, actuators and intelligent devices that will monitor, control, analyse and optimise the world. The advent of IOT, similar to that of the PC epitomized a shift for the economy. IOT integrates other technology such as cloud computing, data analytics, and mobile communications. (Chui, Löffler, and Roberts 2010).

The IOT also opens a range of new business opportunities for a variety of players. These opportunities tend to fall into three broad strategic categories (figure 2), each reflecting a different type of enterprise (Burkitt 2014):

• “Enablers” that develop and implement the underlying technology

• “Engagers” that design, create, integrate, and deliver IOT services to customers

• "Enhancers" that devise their own value-added services, on top of the services provided by Engagers, that are unique to the Internet of Things.

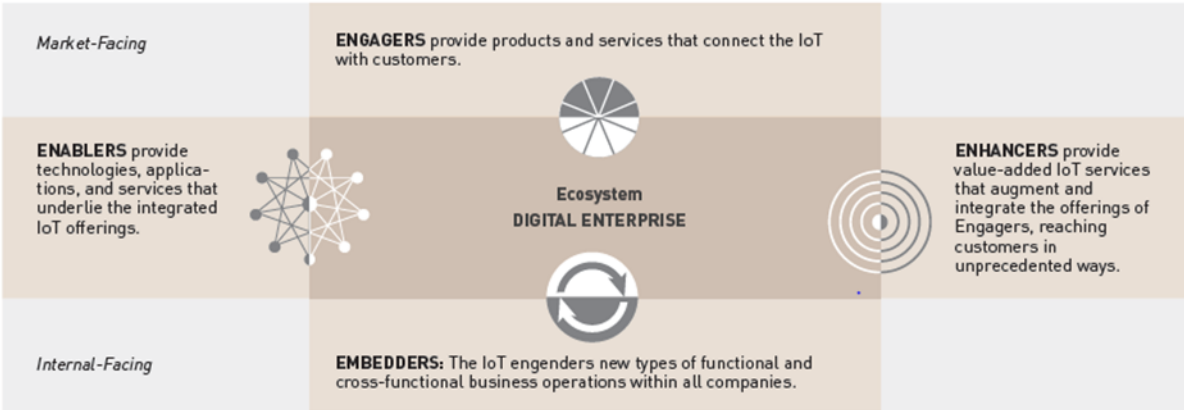

Figure 2 Strategic Categories of IOT (Burkitt 2014)

IOT consists of the following (Burkitt 2014):

1. Endpoints – sensors and actuators that capture data, monitor changes and provide feedback to adjust changes in the environment and using the internet to control objects.

2. Simple hubs -connect endpoints to broader networks. Integrated into products such as vehicle engines; washing machines; or home heating, venting, and air conditioning (HVAC) systems, the computing intelligence and storage embedded in a simple hub allows these products to adapt over time to the user's behavior and to optimize for efficiency.

3. Integrating hubs that connect simple hubs and outside connections are relatively complex devices providing a diverse array of services that fit more or less seamlessly together.

4. Network and cloud services provide the infrastructure of the Internet of Things. They can either be public or private. Provide seamless and transparent connection to the Internet to hubs and collect, store, and analyse vast amounts of data from myriad endpoints. Allow to connect to social networks, so that users of the IOT can compare experiences and share data.

5. Enhanced services – consist of the most sophisticated components of IOT. Make use of the information collected and analyzed by other platforms and services to deliver broad-based interactive functions.

The above mentioned technological options offers a wide range of opportunities for companies to start IOT businesses. Some might start making stand-alone endpoints, and move up to producing hubs. Others might parlay their expertise at integrating hubs into providing network and cloud services—or vice versa (Burkitt 2014).

2.4 Social Internet of Things

Currently there is a new concept being studied, Social internet of things (SIoT), whereby objects established social relationships with each other's. The idea came from creating a service that allows similar devices to share best practices to solve problems among friends given proper authorization. The aims of such relationship is defined as follows(Atzori, Iera, and Morabito 2011):

1. Structure IOT to guarantee network accessibility so that efficient service discovery can be carried out while ensuring scalability.
2. Create trust to leverage level of interaction between things that are friends.

Table 1 illustrate the benefits of SIoT (Atzori, Iera, and Morabito 2011).

Table 1 SIOT benefits

Reason for Humans	Reason for Things
Become visible/increase popularity	Publish information/services
Find resources/find old friends	Find information/services
Obtain context information and get filtered information	Get environment characteristics
Discover new resources and find new friends	Find new services/updated information

Atzori et al.2011 argue that 'standards for the IOT should support the establishment and management of federations of objects (related by social relationships) that can interact in a more strict way and rely on each other's for the execution of complex tasks. This, however, should not prevent the establishment of loose interactions between objects not related by social relationships'(Atzori, Iera, and Morabito 2011). They also mention the importance to develop a standard guideline of interaction between different networks of social objects early in the deployment phase.

Overlapping connected clusters in a social network is a source of value in social relationships. The following relationships were proposed by (Atzori, Iera, and Morabito 2011).:

1. **Parental Object relationship** – relationship that exists between similar objects that are built from the same batch by same manufacturer. The relationship remain the same over time and is easily incorporated during manufacturing. It is updated only in the case of disruption/obsolescence of a particular object.
2. **Co-location object relationship** – the object such as sensor, actuators, RFID (Radio frequency identification) Tags stays at the same place come into contact with other objects to share personal (cohabitation). Example in home or industrial automation application.
3. **Co-work object relationship** – Objects collaborate with each other to share work experiences and provide IOT application. Examples are emergency response and telemedicine.
4. **Ownership object relationship** – several objects such as mobile phone, music players, game consoles that belong to the same owner.
5. **Social Object Relationship** – object interacting with each other due to friendship between the owners.

Alan Fiske(Fiske 1992) develop four relational models for social relationship that can be extrapolated to the concept of social objects.

1. 'Communal sharing relationship where equivalence and collectivity membership emerge against any form of individual distinctiveness'.
2. 'Equality matching is based on egalitarian relationships characterized by in-kind reciprocity and balanced exchange'.
3. 'Authority ranking relationships are asymmetrical, based on precedence, hierarchy, status, command, and deference'.
4. 'Market pricing relationships, finally, are based on proportionality, with interactions organised with reference to a common scale of ratio values'.

2.4.1 Components of SIoT

The first thing is to understand the Social Network Service and its components which are (Atzori, Iera, and Morabito 2011):

1. Profiling – the users give a description of themselves and add information along with updates.
2. Social Graph – module that publicly or semi-publicly show the links between members and their friends.
3. Social Presence – offers the possibility to view other profiles of friends.
4. Participation Tools – permit communication with friends through emails, instant messaging, chat rooms, blogs, message boards, telephony and videoconferencing.
5. Relation Control – users can restrict usage according to their preference.
6. Service API – permit the integration of third party services or external sites to the SNS.

(Atzori, Iera, and Morabito 2011) defined the following as the social component for objects and these are illustrated:

1. ID management: to use an interoperable system for ID existing mechanism.
2. Object profiling: contain static and dynamic information about the object. The object is arranged in different class which define the main object features.
3. Owner control: the owner define the activities, information to be made available in the system and set up the parameters for relationships according to specific policies.
4. Service Discovery: the aim is to search for objects that offer the necessary service just as human seek for friendship and information.
5. Relationship management: to permit object to start, update, and cut off relationship with other objects. The human control setting define which friendship to accept the way the object interact are governed by a set of rules.
6. Service Composition: allow contact among objects which consist of retrieving information about the surrounding or find a service provider.
7. Trustworthiness management: the aim is to figure out how information is processed. Depending on the behaviour of the object, reliability is built and related to the relationship management module. Notions such as centrality and prestige can be used.
8. Service APIs (application program interface): same as that for SNSs.

'To support the deployment of the model, a specific ontology is needed to record and represent the objects profiles, their friendships, as well as the relevant relationships. This has to be designed taking into account the objective of managing the relationships but also considering that the same ontology is used in the other components, especially for service discovery and trustworthiness management'(Atzori, Iera, and Morabito 2011).

2.4.2 SIoT architecture

Atzori et al. 2011 propose the following architecture as illustrated in Figure 3

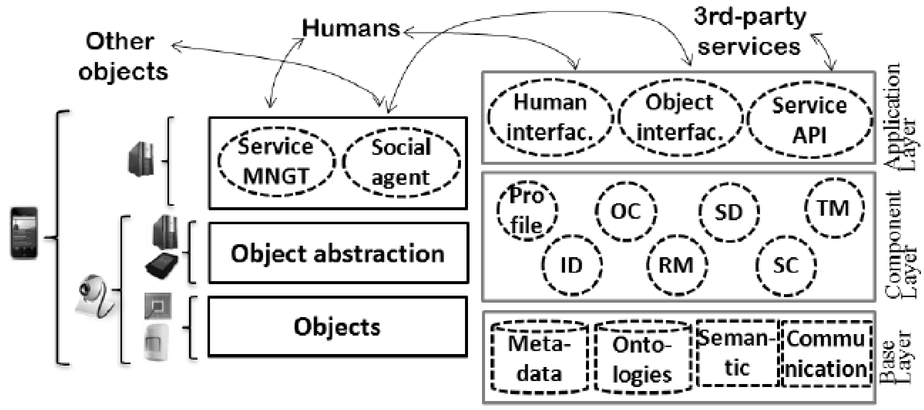

Figure 3 SIOT Architecture (Atzori et al. 2011)

The server of the SIoT consist of three layers. The base layer consists of the database for storage and management of data such as human and objects behaviors. It also comprise of the ontologies, the semantic engines and the communications. The component layer includes functional tools such as profiling, ID management, owner control, relationship management, service discovery, service composition, and trustworthiness management. The application layer is the link to the objects, humans, and services through the use of interfaces.

On the object side, the first layer is the object – the physical object is located and grasp through communication interface. The object abstraction layer is required to harmonize the communication of the large and heterogeneous pool of devices through a common language and procedure. A wrapping layer consisting of the following is needed:

1. Interface – responsible for the management of all incoming/outcoming message operations involved in the communication with the object (Atzori, Iera, and Morabito 2011).
2. Communication – implements the logic behind each service methods and translates these methods into set of device-specific commands to communicate with real-world objects (Atzori, Iera, and Morabito 2011).

Some objects maybe very elementary, such as an RFID-tagged object, while others may be equipped with an embedded TCP/IP stack, like TinyTCP, mIP or IwIP, which provide a socket like interface for embedded applications. In the first case a gateway is required to implement such abstraction layer, while in the second case this layer can be implemented in the object itself(Atzori, Iera, and Morabito 2011).

The third layer consist of the social agent which links to the servers for update, search and request new services. The social agent is also responsible to communicate to close proximity objects or when direct communication is required between objects. The service management is responsible to allow the human to control the behaviour of the object during the interaction in the social network. Usually this layer is on a separate network or incorporated in the object.

2.5 Conclusion and Research Contribution

With the rapid advent of technology and the fast growth of portable devices with strong communicating capabilities, the idea behind the Internet of Things is taking form. Indeed, Smart services are gradually growing and adapting to the concept of Internet of things. However, from the literature study we identify that there is a lack of research on how product service system linked with smart services. Both smart services and product service system has the aim to provide something which is sustainable and efficient to the society. Also, the Social Internet of Things being a new paradigm, there is a lack of research on its applicability. To this end, this research aim to reduce the gaps identify by designing a product service system under the context of the Social Internet of Things which eventually leads to a creation of a smart service.

3 Methodology

Creating new service is a complex process as it involves the integration of several disciplines to group the channels, people, processes and technologies required together (Patrício et al. 2013). This chapter describes the methodology used to create a Product Service System under the context of Social Internet of Things.

3.1 Service Design Approach

Service Design is a fast growing multidisciplinary field that combines service science and design thinking, incorporating parts of services marketing, interaction design, operations management and information systems to provide an offering which enable cocreation of valuable customer experience. The birth of new or improved service offerings, service processes and service business models is called service innovation(Ostrom 2010). Verganti (2009) further argues that a profound way of creating design – driven innovation is to give new meanings of customer attributes to the service resulting in a change in how customer relates and co-creates value through the service. According to Patrício et al. (2011), 'Customer experiences cannot be designed, but services can be designed for the customer experience' (Patrício, Fisk, and Constantine 2011). This leads to the holistic and flexible design of service that enable allow smooth co-creation of customer experience across the different service encounters. By ensuring that service interfaces have value to both customer and service provider, service design provides a platform for the formulation of service idea(Mager 2009). When creating new services, the what to design and how to design is primordial. Indeed, service design is an iterative human – centred process that include understanding customers, stakeholders and the contexts. Then this knowledge is transferred into composition of the service design elements (Evenson 2008).

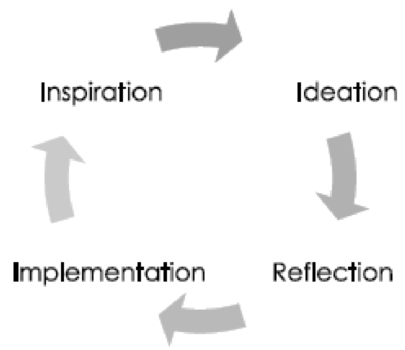

Figure 4 Service Design Process (Patrício et al. 2013)

Service design starts with the analysis of needs and behaviour of people to be involved in the service being created. This allow a wider picture of the design space to generate innovative ideas. The iterative process of service design go through four stages namely (figure 4):

1. Inspiration: the study of stakeholders, their experience, behaviour and context in a human-centred design approach.
2. Ideation: involving stakeholders in multidisciplinary team to gather and develop ideas.
3. Reflection: prototyping the service concept and test with potential users.
4. Implementation: planning, implementing and reviewing changes in the service concept to offer to clients. This process is iterative and require review once launch in the market.

The basis of service design is to creatively adapt the understanding of customer experience to delineate service solution. Indeed, this task is challenging due to the complex nature of services the abundance of experience information. Evenson and Dubberly (2010) proposed two main stages of design process namely, analysis and synthesis (Evenson and Dubberly 2010). The bridge model was adapted to service design by Patrício et al. 2009 (Figure5) and start with understanding the richness of customer experience. Then the customer experience information is modelled with technique such as customer experience modelling proposed by Teixeira et al (2012). The next steps is to explore new service concepts and test it through the use of prototype before implementing the solution.

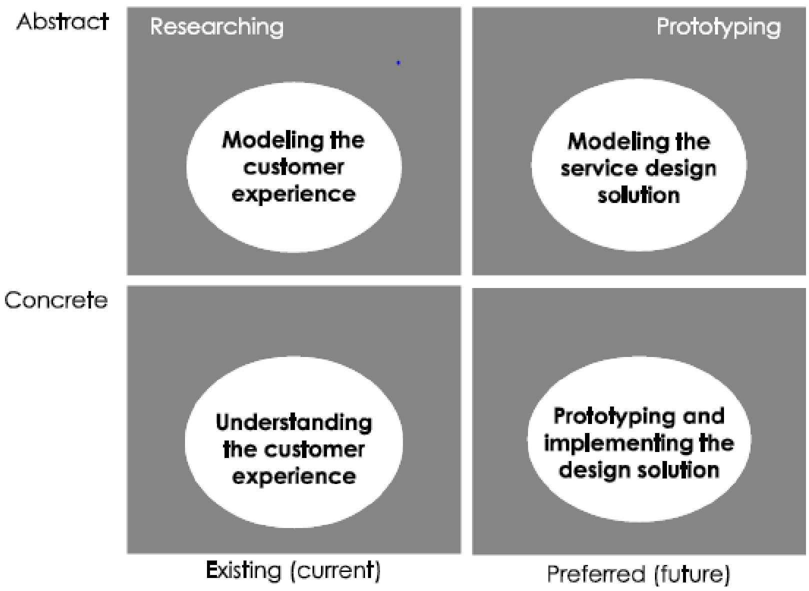

Figure 5 Services Modelling (Patrício et al 2013)

Multilevel service design is an interdisciplinary method combining contributions from interaction design, service science, management and engineering for the design of complex service systems (Patrício, Fisk, and Constantine 2011). Patrício and Fisk (2012) argue that 'the MSD method enables integrated design of service offerings at three hierarchical levels with a strong focus on the customer experience (Figure 6): designing the organization's service concept; designing the organization's service system; and designing each service encounter'(Patrício et al. 2013). The first step is understanding the customer experience (Inspiration Space). The study of the customer experience is performed at three levels, the value constellation experience, the service experience, and the service encounter experience using data collection technique. The next step (Ideation space) is to design the service concept based on the information gather on the customer experience. At this stage the Customer Value Constellation is designed and show the set of service offerings and relationship that allow customer to co-create their value constellation experience for a particular activity. The third step involved the design of the service system architecture SSA and service system navigation SSN. 'The SSA defines the structure of the service system, providing an integrated view of the multi-interface offering and support processes across the service experience while SSN maps the alternative paths customers may take across different service encounters in the service experience'(Patrício et al. 2013). The last step involved blueprinting the service encounter using the service experience blueprint.

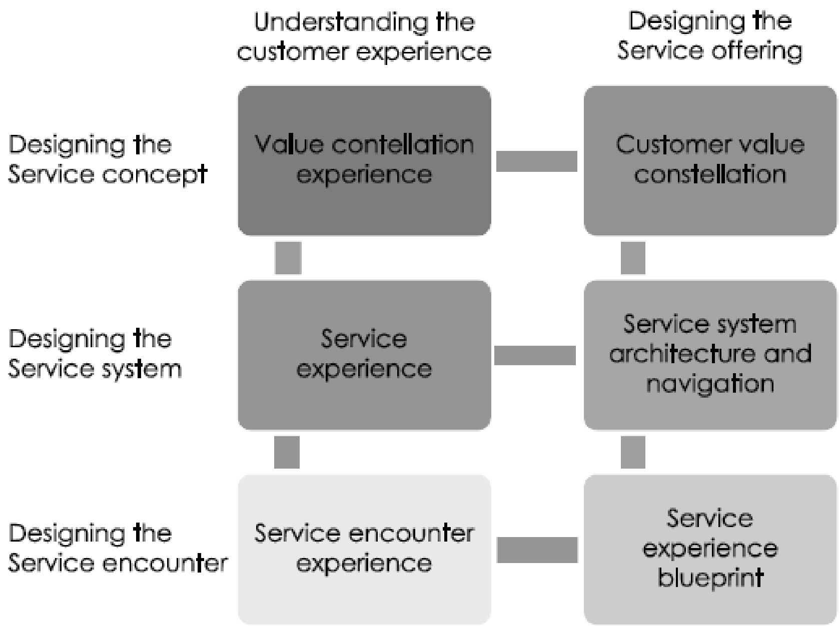

Figure 6 Multi-level Services Design (Patrício, Fisk, Cunha & Constantine, 2011)

3.2 Design Science Approach

Design Science is a paradigm that create innovative artifacts by making human and organization to go beyond their capabilities. According to Simon, engineering and the sciences of the artificial are the root of design science paradigm. It is usually used for problem solving. The process looks for innovative ways to delineate ideas, practices, technical capabilities and products. The analysis, design, implementation, management, and the use of information systems can then be realized effectively and efficiently.

Hevner et al. 2004 argue that design science addresses research through the *building* and *evaluation* of artifacts designed to meet the identified business need and its goal is utility. The knowledge base is the source of raw material and comprised of Foundations and Methodologies. Methodologies give protocols in the evaluation phase. A good balance use of foundations and methodologies creates rigor. Hevner et al. 2004 mentioned that in design science, quality and effectiveness of artifacts are assessed mainly by computational and mathematical methods while empirical techniques as well can be used. Good artifacts are designed to tackle unsolved problems and are evaluated on the basis of how useful they were in solving the problem. The environments depict the problem definition and are composed of people, organizations and technology. In this section the business need is defined as the goals are set, tasks planned and problems identified. These needs are evaluated with regards to the organizational strategies, structure, culture and existing business processes.(Silver, Markus, and Beath 1995).

It is important issue in design science to distinguish between routine design and system originated from design research. Routine design can be defined as the use of actual expertise to solve organisational problems. On the contrary, design science research tackle unresolved problems in an ingenious way. According to Hevner et al. 2004, as design-science research results are codified in the knowledge base, they become best practice. System building is then the routine application of the knowledge base to known problems.

The seven guidelines as proposed by Hevner et al. 2004 are adaptive and process-oriented. The fundamental principle of design-science research from which the seven guidelines are derived is that knowledge and understanding of a design problem and its solution are acquired in the building and application of an artifact (Hevner et al. 2004).

Hevner et al. 2004 came up with seven guideline and they are:

1. Create a resolute artefact.
2. The artefact need to address a specific problem.
3. The artefact must be well evaluated through specific method.
4. The artefact must bring innovative contribution to the field.
5. The artefact must bring rigor.
6. An effective solution is found through an effective search mechanism provided by the artefact.
7. The design science research is effectively communicated.

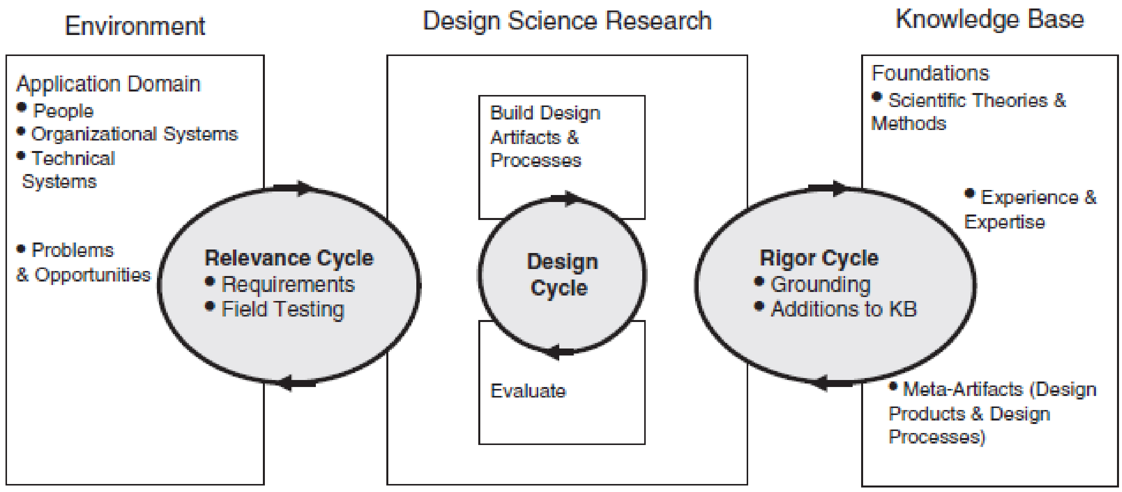

Figure 7 Design Science Research Cycles (Hevner 2007)

Figure 7 above shows the framework as described by Hevner et al. 2004 and illustrates three important research cycles. The relevance cycle links the environment with design science activities. With the use of the context, the design science research. This steps defines the inputs as requirements and also delineates the compliance criteria for the final evaluation of the research results. The output is studied and evaluated back in the environment. According to (Cole 2005) and (Jarvinen 2007), a technology transfer methods like action research can be used for the field study of the artefact. Depending on the results obtained in the field testing, more iteration of the cycle might be needed. The usage of the new artefact might have some faults in functionalities and qualities. It can happen that the initial input fed were wrong and in that case, the requirements need to be reinstated correctly.

The rigor cycle bridges the design science activities with the knowledge base. Scientific theories and engineering methods cater for a meticulous design science research. The knowledge base comprises of two additional knowledge:

1. State of the art in the application domain
2. Existing artifacts and processes in the application domain

The cycle ensures innovative ideas are generated through the provision of knowledge. The design cycle go over the building and evaluation, acting as a feedback. Simon (1996) describes the nature of this cycle as generating design alternatives and evaluating the alternatives against requirements until a satisfactory design is achieved. The relevance cycle provides the requirements while rigor cycle provides the design, evaluation theories and methods.

3.3 Research Plan

The following sections will describe in detail the research plan used to design a Product Service System under the Social Internet of Things and in the present case, it is the design of a smart social bike that will be therein referred as SSB.

3.3.1 Problem Identification and motivation

The first step before embarking on the service design approach is to understand and define the environment. Following Hevner et al. (2004), the problem and motivation are defined with CEIIA in order to come up with a new Product Service System. Several meetings were undertaken with the project supervisor at CEIIA so as the problem is defined and fit with the strategy of the company. From the design thinking approach, this stage is in the inspiration phase. This step is used as it act as a guideline for the further processes at the later stage of the project. It help to focus on the main issue and will allow to guide the research towards its goal. Bike Sharing being a very broad subject that touches a lot field, it is important to have a strong foundation with objectives well set.

3.3.2 Understanding the Customer Experience

Pine and Gilmore (1998) argue that a differentiating factor in an organisation offering is the customer experience (Pine and Gilmore 1998). It is very important to understand the customers, who they are, what they like and dislike about the current system. Also, understanding the context and activities involved is primordial. This study helps in the development of the next phases, ideation, reflection and implementation (Patrício et al. 2013). A study was performed on the current bike sharing system to understand the different elements; people, process and technology that constitutes such system. A preliminary insight was obtained about its users and stakeholders. The stakeholder for SSB were identified following a research on current bike sharing system and meetings with supervisor at CEIIA. The stakeholders will be the one responsible to make the system operable. The stakeholder map is given in figure 8.

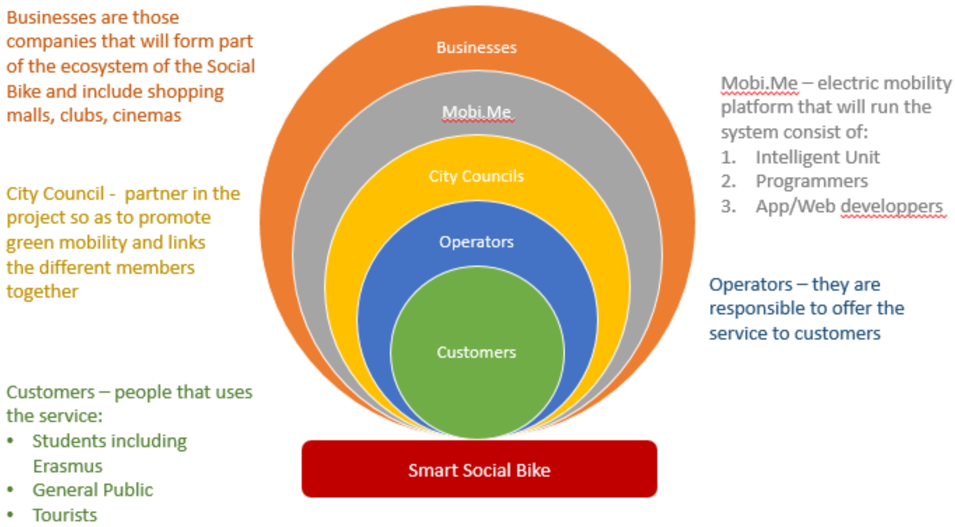

Figure 8 Stakeholder Map

Interviews, observation and questionnaires are tools that are used to gather useful information about the current context of bike sharing system and it helps to validate the initial idea as well. Through the qualitative and quantitative study, the market segment is identified and assumptions and constraints for the new project are defined. By identifying the market segments, you are in a position to tailor-made services for each need of the different segments. Within the context of the project, to understand the experience of bike sharing users and operators of these systems are very important to understand problems faced, the level of satisfaction and their needs. The data collection will be made as follows:

1. Preliminary investigation on social media to get a first insight on the feeling of people using the current bike sharing system were undertaken. The different bike sharing systems were searched on Facebook in order to get a view from the customers. Only Bicing the system from Barcelona and Bicincitta from Italy had a page where users could post feedback. The page of Bicing is quite busy as there are lots of posts which is not the case of Bicincitta. For Bicing the post taken into consideration was for six months from September 2014 to February 2015 while for Bicincitta it was more scattered since the information is not published quite often, ranging from January 2014 to February 2015. Nowadays, social media is being used as a channel to reach customers since more people are active on the social media. It is interesting to see how current bike operators uses such channel.
2. Interview of operators of bike sharing system to get insights on how they manage the system, what problems, challenges they faced etc. In this case, the sample will be selective as in Portugal, the Municipality usually operates the scheme. The responsible person of Buga at the Municipality of Aveiro was interviewed. The questions are given in appendix B.
3. Interview the users of bike sharing to gather data on their level of satisfaction. It is important to get a face to face interaction with the users as it provide not only qualified data and also allow the interviewee to observe the body language of the user. Here, the sample is random because different people from different background use the bike. The questions were designed into two sections where the first section concentrate on gathering data on the current system and the second section, selling the new concept indirectly. The questions used are given in the appendix A. An interview were carried out in Aveiro on two different days, Thursday 19th March from 12.00 to 16.00 in the afternoon and on Saturday 21st March from 14.30 to 18.00. A random sample was used in this study as a lot of people with different background uses the bike. The study was a little limited because of the following reasons:
   - People are not fluent in English and are a bit reluctant to participate.
   - People although accepted to participate in the interview, are always in a hurry and gave quick and straight answers.
   - When trying to go into details, exploring the reasoning of why they are saying something, the interviewees does not really know how to express their opinions and are also a bit reluctant.
   - Due to language barrier, people that speak English were interviewed.

   The interview process can be enhanced by seeking help from municipalities in order to try and record the interview for latter usage and review.

4. Observations were undertaken on the day of the interviews to grasp how the people behave while using the bike sharing. This helps in understanding the activities involved and identifying solutions to given problems.
5. Using an online questionnaire to try and reach the different users of bike sharing system. The survey was published on social media including bike sharing groups, the page of BUGA, BUÉ and BICING. Also, it was sent to university students with the aim of getting maximum information. The questionnaire is given in appendix C. Questionnaire brings in quantitative data that helps in designing the service system architecture in the later stages of the research.

Qualitative approach used to analyse the interviews with the operators as well as the open ended questions in the questionnaire sent online. Since the interview of the users of BUGA had some limitation, the grounded theory cannot be used for analysis.

Still in the inspiration phase, the service specifications are identified based on the analysis of the study. This helps to give an insight on the potential service concepts that will be developed at the ideation phase. At this level, to understand the walkthrough of the users and well as their experience is very important and tools such as Customer Journey, Customer Experience Modelling are used so as to support the design of the new service in the latter stage as it helps capture information across all the interaction in the service provision and also helped in identifying activities involved (Teixeira et al. 2012). Benchmarking can be defined as a method of comparing two or more 'things' which can be objects, services which are somehow related. In the current context, it is important to see the different bike sharing system that exists and see what their components are. This gives an indication of how to better position the new offering with regards to the competitor.

3.3.3 Designing the service offering

Going into the ideation phase, new service concept are explored. The service concept proposes the range of gains that the service will offer and positioning it in the Customer Value Constellation. The service concept helps in answering the research objective of proposing a set of services for SSB. The service system describes arrangement of actors, artefact and technologies in the front stage and back stage. The service system architecture (SSA) and service system navigation (SSN) is drawn at this stage. These tools are drawn based on the previous steps described, give an overview of who is going to be involved for a particular activity and what technology is required. A scenario is included in the SSN with the personas as it gives a clear picture of what happens and how the system will function. Also, it helps in designing the mockups. The service encounter commonly referred as touchpoints describes in detail the interaction of the customer with the different interface available for the service (Patrício, Fisk, and Constantine 2011). Each of these steps is validated with the supervisor of the project through meetings. The service blueprinting is used as it helps to enhance the design of service encounter and also help identifying bottleneck that affect customer experience (Patricio et al., 2013). The actor network mapping (Morelli and Tollestrup 2007) is drawn up next as it gives a clear picture of the interaction between the different stakeholders and what each one is giving and gaining while using the service.

3.3.4 System Architecture Design

Still in the ideation phase, the first step is to define the super goal of the service and sub goals that are required to support the super goal. This goes in line with the objectives set in the previous step. From the goals identified, the KAOS diagram is drawn to decompose the relationship between the goals and help identify the agent responsible for the goal. Use cases can be defined as task that are performed by actors involved in the system in order to accomplish a goal. The scenario description for the use case shows the different interaction between the actors and the system during the accomplishment of a task (Pohl 2010). The aforementioned steps are used as it help defined what is intended to be accomplish and give the base information to draw the system architecture. Then, a system architecture is drawn to show the involved entities. Modules of operation and security are added. The service concept defined earlier helps in defining the operation components. The security module deals with privacy of accounts and will act as a double shield in the architecture. The SIOT architecture proposed by Atzori et al. (2011) is adapted to fit the purpose of the project. Following this, the functional requirement which state what the system should provide and the quality requirements which defines the quality properties of the system are identified (Pohl 2010). Mockups are finally drawn to show how the system will look like.

3.3.5 Define Business Model

The last and final step is the design of the business model through the use of the business model canvas. This will allow the stakeholder to get a better understanding about how the system will be operated and managed.

3.4 Overview and Justification

To understand customer's context and needs form the base of service design at the inspiration phase. This requires a rich collection of data on the customer's context, needs, activities and the stakeholders involved in the creation of the customer experience (Patrício et al., 2011). The research used a design science research methodology nested in the design thinking approach. The first step of understanding the customers and the context follows the relevance cycle as it will help identify problems and help set a goal. At the ideation phase, the rigor cycle helps to link knowledge obtained through state of the art and studies performed to come up with innovative ideas. At the reflection and implementation phase, the design cycle helps in building and evaluation phase of the product service system. Using a design science approach with the service design will help address the research questions and design a Product Service System under a Social Internet of Things.

4 Results of the Study of Customer Experience

This chapter describes the results obtained during the quantitative and qualitative study and further explore the customer journey of the current bike sharing services. Bike sharing is a process of offering bikes as a mean of transport without the user owning any proprietary rights on the bike. They just pay a sum of money and uses the bike for their needs (Meireles et al. 2013). Bike Sharing differ from traditional, mostly leisure-oriented bicycle rental services, they can be “rented” at one location and either returned there or at another location, they provide fast and easy access, they have diverse business models, they make use of applied technology (smart cards and/or mobile phones) and they are often designed as part of the public transport system (Midgley 2009). The data collected were from the social media as the research aim to come up with a smart social bike, to see the role social media is playing is important. Also, data from the interviews, users and operators of such system help orchestrate the findings by providing rich information on their experience with such system and this helps in designing SSB. The data from the qualitative study aim to reach users of different bike sharing to get an idea of the context bearing in mind that in different countries, the service varies. The observation contemplate the interviews as it also help to validate problems users state such as in the instance of Buga, people complaint about security and some users had to returned the bike because of brake failure.

4.1 Social Media Investigation

One observation is that people uses the Facebook page for complaints with very few suggesting improvements such as making provision for a tourist card. Among the problem noted is the difficulty to find and park a bike as stations are either full or empty. Not enough information is provided to the users. The mobile app for the Bicing system is not quiet functional as people cannot locate the stations. Also, there are instances where people are fined even though they parked the bike correctly. People also complained about vandalism and the long time it takes to get the card. One interesting comment was that bike lanes need to be better before embarking on smart cities project.

4.2 Observation during interview

Usually there are lots of people coming to take a bike and there is a lack of bike available. Especially during the weekends, people come and wait for others to return bike so as they can enjoy the free ride after. Indeed, people seek advice from the operators on strategic point to visit in Aveiro and the latter are very friendly and helpful. The main point is that demand exceed supply and this may be due to the fact that the system is free. During school days, the same groups of students took the bike twice to have some fun among themselves. A salient point about the bike itself is that they are badly maintained. Most of them have only one brake and the gear system does not work. However, the bikes with baby seats are safer. Also, people do not check the bike when unlocking, they just take it and start riding.

4.3 Interview Results

34 people were interviewed among which 29 were students. In these 29 students, 18 were Erasmus students. Most interviewees describe their experience as very good. They see this service as something which is fun and that allow them to discover the whole city. Also, they

argue that the bike is very useful for a quick mean of transport. Despite liking the system, the respondents suggested some improvements which evolved around the bike itself, they want more bike with better comfort, properly maintained, two seated bike and having locks available. Two people proposed to have guide to show around the city and to have more stations around the city. One interesting comment came from a user of BUGA of almost 12 years and he argues that the best improvement for the system is a change in the mind-set of the community. For him, people need to be more responsible and use the bike as their own one. One person also argue that the system is free and they cannot expect to have a five star bike. Moreover, people propose to have bike path as there are too much car around the city. The use of camera to prevent theft was also proposed.

Most respondent have their own bikes and prefer to use their own bike as it is more personal and safer. They also think that their own bike is more flexible as they do not need to go to a shop to take a bike. Their own bike is readily available. On the other hand, some people prefer BUGA depending on the situation for instance, if they are outside their home town, BUGA is a good fit and fantastic for them. The majority of the interviewee used the BUGA for the first time, one student used the bike thrice in the space of 5 days to go to university and visiting around the city. The users were asked their opinions and rate on a scale of 1 to 5 with 5 being very good and 1 very bad about the Bike, Station, Information Kiosk and the Personnel. The response were very positive and the respondent gave good rating (table 2) to these criteria which shows a high level of appreciation for the BUGA.

The next step of the interview was to try and sell indirectly the idea of the social bike and see the response obtained. The new service intended to be implemented will cater for owners of private bike as well. In this context, the interviewees were asked about whether they would be willing to make their own bike a smart one and be integrated in the new ecosystem. The majority thinks it is a good idea while two people think that the bike should be kept simple. An interviewee argue that there are already alternative with mobile app that can be used. One interesting point brought up by a student is that with a smart bike, you get the feeling of being controlled.

Moreover, when asked if a smart bike is a good alternative to the current BUGAs, the majority of the interviewees think that is it a very good idea as the smart bike will allow them to travel without having to stop and use a map to find places of interest and also it is technologically more developed. On the other hand, some people think that a smart bike will make them lose touch with nature and want the bike to remain simple as well as free. They think that a smart alternative will incur more cost. Also, most interviewees think that connecting a smart device to the bike is a good idea, while some are a bit sceptical since the usage of a smartphone nowadays is for calling, texting and social media. Concerning the issue of theft and vandalism, the responses were mixed, some do not know how a smart bike can address such issue, and a section thinks it is a good idea while others think that it depends on the people. The mind-set of people plays an important role and even with high risk, and they are prone to theft. Also, if people are able to switch the system off, theft and vandalism will still occur. This is an important issue that raise concern on the design of the product itself. Features such as having information on bike riding pattern were welcome and think that it is very good for sports people. However those that are against such features think that a bike should be simple and in the instance someone want to know the distance covered, he can always use google maps. The idea of being able to be localised through a GPS got a very good approval with only two people thinking that they will not have freedom and will feel like being watched.

4.4 Analysis of Questionnaire

148 people responded to the online questionnaire. From this population, 51 % were male and 49% were female. Around 89 percent of the respondent age from 16 years old to 33 years old. The population are educated people with 63% having a university degree. The majority of the respondent are students since the questionnaire got more response from the email sent to different faculties than the other group posted on Facebook. 62 % have their own bike and uses it less than 3 times a week. Some also use it only during the summer. The most chosen reason for riding a bike are for leisure and sport. One interesting point from a Dutch guy, he mentioned that in Holland, people use the bike for every purpose, school, work and also one person use the bike for shopping and to go to hair dresser.

One interesting information from the population, only 31% heard of bike sharing system and out of that number, only 8% use one. This can be attributed to the fact that most respondent are Portuguese student and they are not quite conversant with the system. The bike system that were used are the following:

1. BUGA in Aveiro, Portugal
2. Bicing in Barcelona, Spain
3. Velib in Paris, France
4. Bicais in Caicais, Portugal
5. London Hire Bike Scheme in London, United Kingdom

The main reasons for using such system were tourism, leisure and commuting. The frequency is less than 10 times a month with only one user with greater than 10 times a month with commuting distance varying 3 to 10 km. From the users of bike sharing system, 5.4 % uses other mean of transport with the main one being metro.

People became aware of the system mainly through the internet, newspaper, word of mouth and just seeing the system on the street. The majority of the users do not know whether the service information is available on the web or mobile app and most of them did not use either. The main reason to use such system is to preserve the environment and it is fun and the most chosen problem is too much traffic. The good aspect of the system is the price, being readily available and accessible with an easy way to use. The rating of the service in general shows that the channels reaching the customer are not very well designed. Overall, people like the bike and the customer support service along with the physical presence (information kiosk). All the users will use the system again showing a certain penchant for this kind of service.

The users describe the experience as positive and were satisfied with the system as it is flexible especially when they are in a foreign country. They were happy overall with the bike sharing they used with proximity station being available. On the other hand, problems that they faced are as follows:

1. No enough bikes
2. There are not enough stations
3. The bikes are heavy and difficult to lock and unlock
4. The stations are either full or empty
5. The bike are not well maintained

Note that in some systems, customer complaints are not well treated and they have a feeling that the price paid is quite expensive. They also think that the mind set of people also need to be address so as they become responsible. They also complain about lack of bike lanes.

One section of the questionnaire also consisted to see how people react to the concept that pretend to be implemented. Respondent think that in identifying empty station autonomously, will make the smart bike a better alternative to the current system. They gave equal importance for the smart bike providing a better riding experience and safer as well as being intelligent in tracking traffic pattern and preventing loss of bike.

The majority of the users of bike sharing thinks that it is a good idea to establish communication between a bike and a smart devices. The reason is that this kind of system will act intelligently, providing that important information on station availability for parking to reduce inconvenience. They also believe that the information gathered will help the users as well as the operators. Only one person thinks that such system is not necessary. On the issue of theft and vandalism, the respondent are not quite convince 8.3 % believes that a smart bike will reduce these problems. 13 % people think that a smart bike will reduce problem of empty and full station. One interesting comment was that to reduce theft, Velib make use of insurance payment that is return at the end of the trip through usage of credit card.

7.5% of people think that localising your bike through a smart phone is an excellent idea as it is helpful at any moment. On features that a smart bike will have such as monitoring gear change pattern, keeping track of maintenance and repair performed, monitor usage of brake during ride and recording distance covered daily, received a good rating.

The same set of question were asked to people that have not used a bike sharing systems. 85.1% of respondents think it is good to establish communication between a bike and a smart device. Among the reason argued are the fact that in their opinion, a smart bike will be an innovative system that will help in reducing theft as the bike will be easily localised and traceable. They also think that such a bike will allow them to understand better the equipment so as they can personally customized it. Moreover, they think that the riding experience will be better and useful as they can set up their preferences. On the other hand, people that think a smart bike is a bad alternative argue that the main problem will be in terms of privacy and security as anyone can track where they are and they do not have much freedom. Also, for them, riding a bike is for leisure and a way to connect to nature and they do not see the necessity of collecting such data.

77% of respondent think that a smart bike will help in solving problem such as theft and vandalism. They believe that with an integrated alarm system, it will be easier to track and notify the police when a bike is missing, thereby reducing losses. They believe that such system will sensitize people against theft. On the other hand, people think that such a system is more prone to theft and vandalism as they are more technologically astute. In their opinion, vandalism is difficult to predict and control and if people switch the system off, there is no security.

84% of the respondent think that it is a good idea to localise a bike through a smartphone. The reason they mentioned are that it will be a great, simple and quick way of localising your bike at any moment. Some mentioned that they forgot location quite often, so this system is very helpful. On the contrary people argue that if the device can be switched off, anyone can steal the bike and there is no way to trace back. One interesting comment was that in small cities, there is no need for such things as there are no robbery.

On features that a smart bike will have such as monitoring gear change pattern, keeping track of maintenance and repair performed, monitor usage of brake during ride and recording distance covered daily, received a good rating. The audience think that these features are a good idea. The questionnaire sample as well as the answers are given in appendix C.

4.5 Conclusion from Qualitative and Quantitative Analysis

From the study, we conclude that the current bike sharing systems are well appreciated among their user communities (Rating in table 2 and appendix C, questionnaire response). People uses the system to commute as well as for leisure purposes. An important point to be noted is that people like the simplicity of the system which raises the challenge of seamlessly integrating technology so people do not feel overloaded with technology. They also think that the new ideas and features proposed to them will help solve the problem mentioned in the previous section. The users were not aware whether information on the system are available on the web or mobile app which raise the concern to properly use and develop these channels in the new service to be proposed.

Table 2 Rating of Buga's Service

Components	Station	Bike	Information Kiosk	Employees
Rating	4	3	5	5

Also, from the study and the research on current bike sharing system, the following customer segments were identified:

1. Resident – people living in a specific region which has a bike sharing system. For example, the Bicing in Barcelona and Biconde (JustB system) in Vila do Conde are for residents.

2. Students – age above 14 years old that uses the bike to go to school and universities. For example in Aveiro.

3. Workers – people aged above 18 years old that uses the bike as a mean of transport instead of using cars or other means of transport.

4. Tourists – people on holidays in search for fun experience. The ages of this segment varies.

4.6 Service Specification Requirements

This section will address the problems raised during the study and service specification that can address such problems will be proposed having in mind the concept of Smart Social Bike (Table 3).

Table 3 Service Requirements Specification

Customer Testimonial	Service Requirements
'Not enough information is provided to users'	**The service shall have an updated information to users about bike availability, station status.**
'Get fined even though bike parked properly'	**The service should provide proper corrective measure in case of mistakes.**
'Takes long time to get membership cars'	**The service should process new registration fast**

Customer Testimonial	Service Requirements
'Guide to show around the city'	**The service should provide information on points of interest to visit and also provide a bike buddy**
'Prefer to use their own bike as it is more personal and safer'	**The service should provide safe and well maintained bike**
'My bike is more flexible and readily available'	**The service should provide bikes with close proximity**
'You get the feeling of being controlled, if a smart bike is used, no freedom, being watched'	**The service should provide a system which allow the user to choose to be localised or not**
'Smart Bike will make us lose touch with nature'	**The service should allow and provide discovery of new places**
'If people switch off the system, there will still be theft and vandalism'	**The service should provide security that is controlled through a remote place and users should not be aware of which component is sending information about whereabouts**
'Customer complaints are not well treated'	**The service should treat all complaints as quick as possible and provide feedbacks**

4.7 Defining Customer Experience Requirement from Service Specification Requirement

Patrício et al. (2009) describes customer experience requirement (CER) as 'the perceived attributes of the interaction with a service provider that contribute to satisfaction and usage of the service (Patrício, Falcão e Cunha, and Fisk 2009). This methodology as used by (Teixeira et al. 2012) in customer experience modelling is applied to identify the CERs 'which describe customer's desired qualities of an experience, thus acting as an evaluator'. The CERs identified from the study are:

1. Availability: there is always bike on standby ready to be used
2. Engagement: the interaction with the employees
3. Convenience: the ease of use of the bike
4. Reliable: well maintained and secure bike
5. Fulfilling: comfortable bike that give a good riding experience
6. Range of service: the offering of different cards scheme for different purposes such as youth cards, tourism cards
7. Support service: swift assistance in case of problems
8. Customisation: ability to set preferences
9. Close proximity station: the stations located in defined areas close to each other
10. Balance station: equal number of bikes available and parking slot
11. Privacy: ability to preserve information of users

4.8 Customer Journey

Customer Journey can be defined as a framework that comprises all the activities and occurrences that impact service delivery. 'The Head of Service Design of IDEO described the customer journey as one of the frameworks in the service design process, used to understand how customers behave across a journey, what they are feeling, and what their motivation and attitude are across that journey'(Zomerdijk and Voss 2010). The next two section describe the customer journey for Buga and the current bike sharing system.

4.8.1 Buga

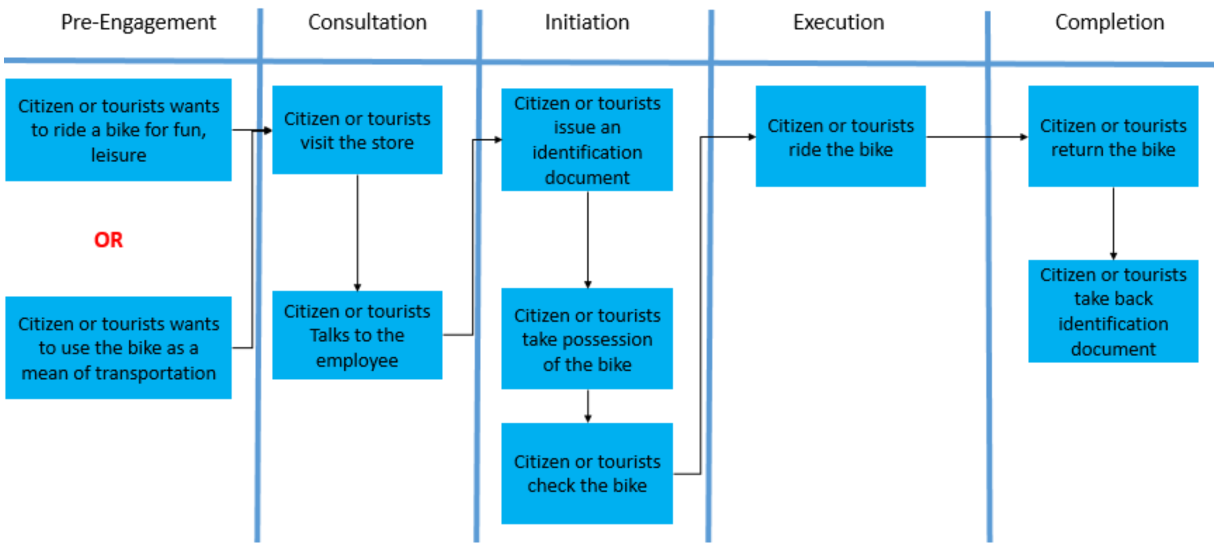

Figure 9 Customer Journey Buga

The customer journey for Buga (Figure 9) starts with the potential feeling of a need to use the system either as a mean of transport or leisure. They visit the store and are welcome by staff that provide them all the information that they need. If they want to use the system, they just provide an identification documents and take the bike for a ride. When they finish their journey, they return the bike in the parking lot and take back their documents.

4.8.2 Bike Sharing System

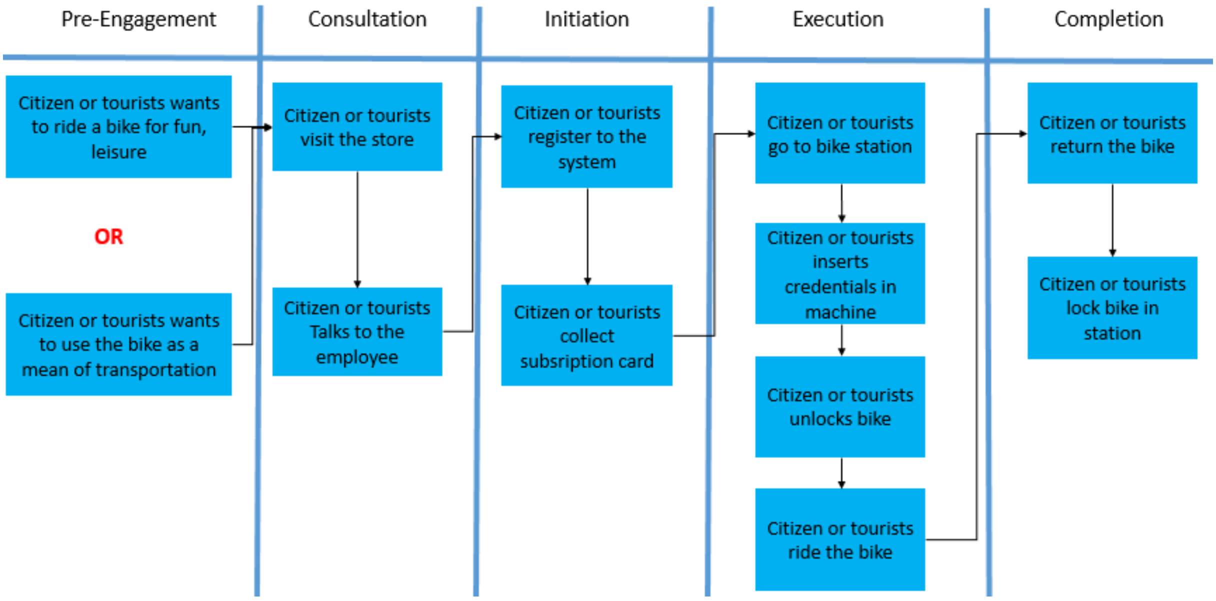

Figure 10 Customer Journey Bike Sharing System

The customer journey for the current bike sharing system (figure 10) start with a potential user finding a need to use the system either for leisure or as a mean of transport. The potential user visits the store where the employees will explain how the system function and the different scheme available. The potential user register, pay the system and collect the subscription card. The user then go to the station, insert the card to the machine, unlock a bike and start his ride. When the user finish his journey, he/she return the bike to the station and lock it to the parking lot.

4.9 Customer Experience Modelling

Teixeira et al. (2012) developed the customer experience modelling (CEM) as a tool that help in acquiring the rich and complex elements that shape an experience. CEM portray the customer journey through the different physical artifacts, technology and actors involved. The tool give a visual depiction that helps service designers in the identification of solution. ‘CEM combines three multidisciplinary contributions to provide a comprehensive and systematic representation of customer experience’ (Teixeira et al. 2012). The first step is to study customer through techniques such as interviews, observation and contextual inquiry. ‘Human Activity Modelling gives the notation and conceptual grounding for a systematic representation of the customer experience, Customer Experience Requirement’s further characterize the experience by pointing out desired qualities, and the three levels of Multi-level Service Design structure the approach and establish the link to service design’(Teixeira et al. 2012).

CEM comprise of three level, the first one being Value Constellation Experience which describe the interaction between users and service provider to undertake a particular activity. The second level is the service experience which ‘systematizes customer experience data from every service encounter with a single service provider’ (Teixeira et al. 2012). Finally, service encounter experience level represents the different touch points with the service provider.

4.9.1 BUGA

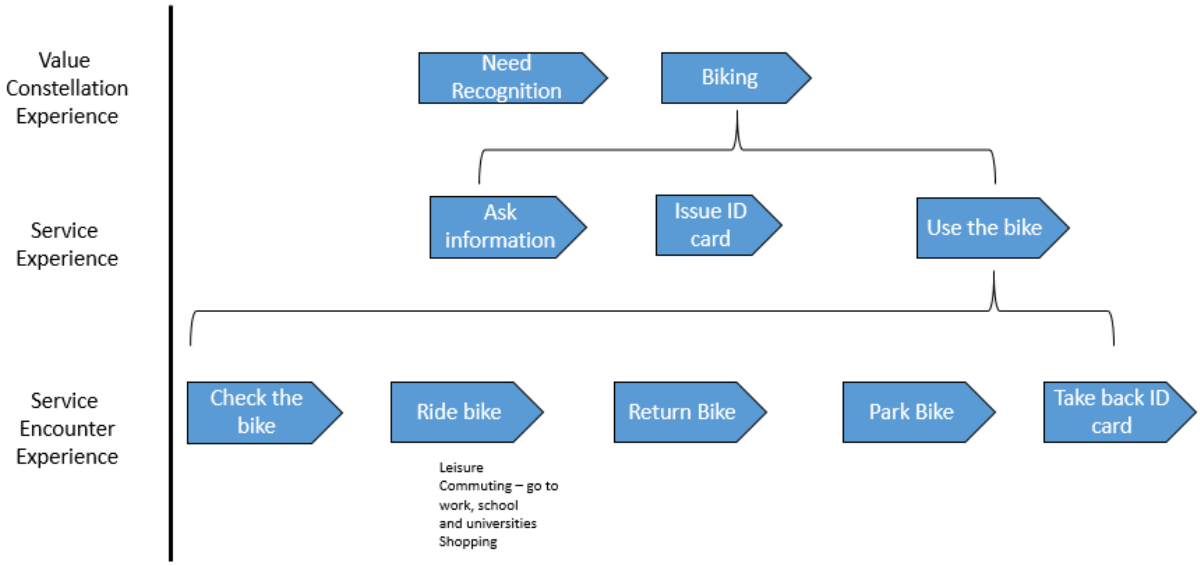

Figure 11 Biking related activities for Buga

The system for Buga (figure 11) is very simplistic and as such does not involved any kind of backend support. The main activities identified at the first level were need recognition whereby users feel the need to go and try the service and biking. At the service experience level, the activities identified are ask information, issue ID card and Use the Bike. The 'Use Bike' is further developed in the next level into activities such as check the bike, ride the bike, return bike, park bike and take back ID card.

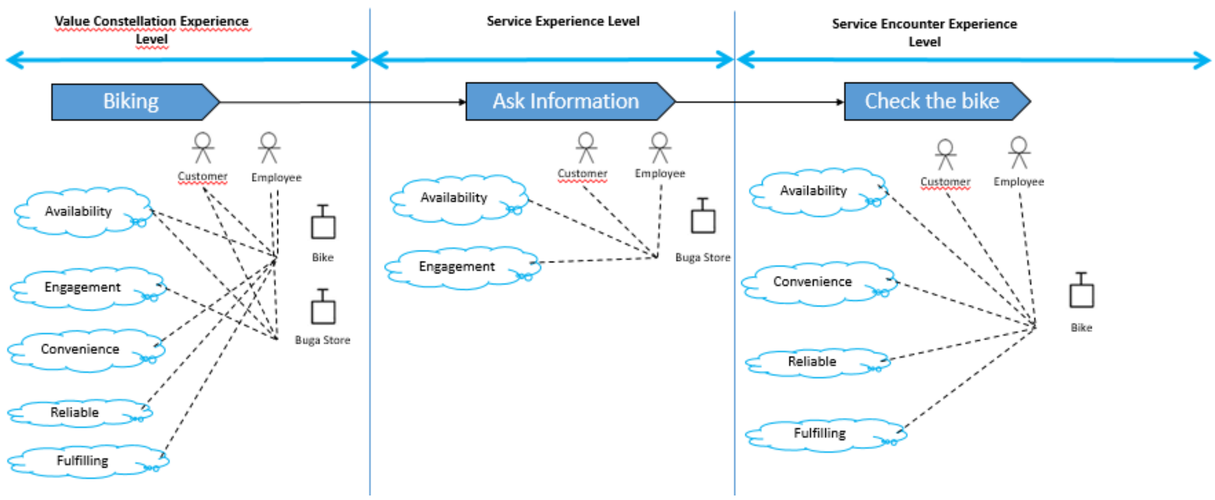

Figure 12 CEM Buga

In the CEM modelling as shown in Figure 12, it can be observed that for the biking activities, the CER's availability, engagement, convenience, reliable and fulfilling are relevant. The artefact involved at this stage are the store and the bike and actors are the users and employees. On the second level, the CERs for the activity 'ask information' are availability and engagement and the only artefact involved is the store. For the last level, the CERs are availability, convenience, reliable and fulfilling while the artefact is the bike. Both users and employees check the bike together.

4.9.2 Bike Sharing Systems

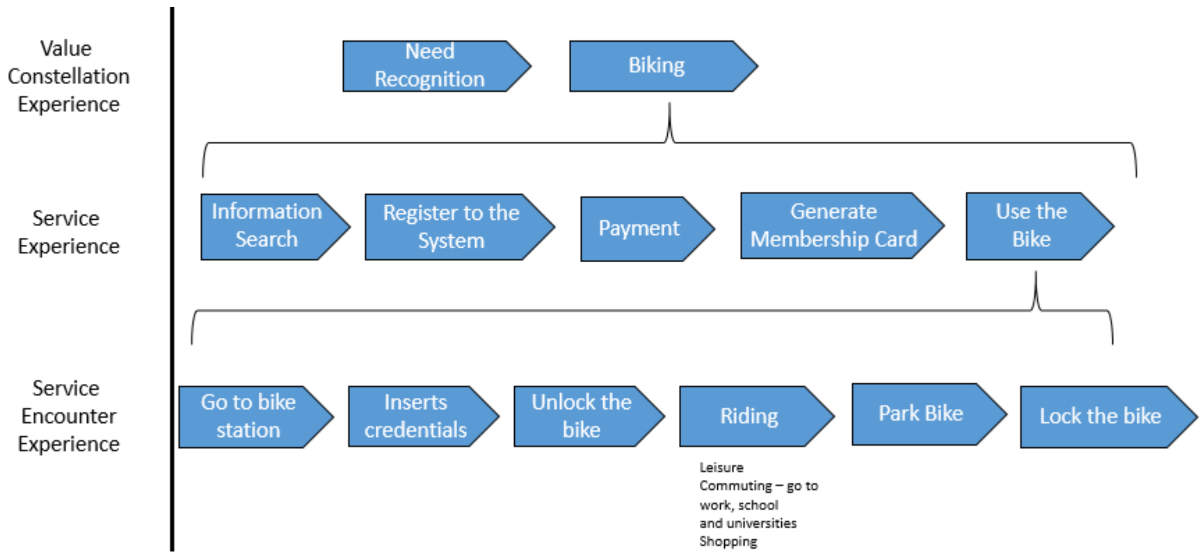

Figure 13 Biking activities for Bike sharing system

The current bike sharing system are quite advance in terms of technology differs significantly from Buga (figure 13). The main activities identified at the first level were need recognition whereby users feel the need to go and try the service and biking. At the service experience level the activities identified are information search, register to the system, payment, generate membership card and use the bike. For the last level, the use the bike activity is further developed to Go to the station, Inserts Credentials, Unlock the bike, Riding, Park Bike, Lock the bike.

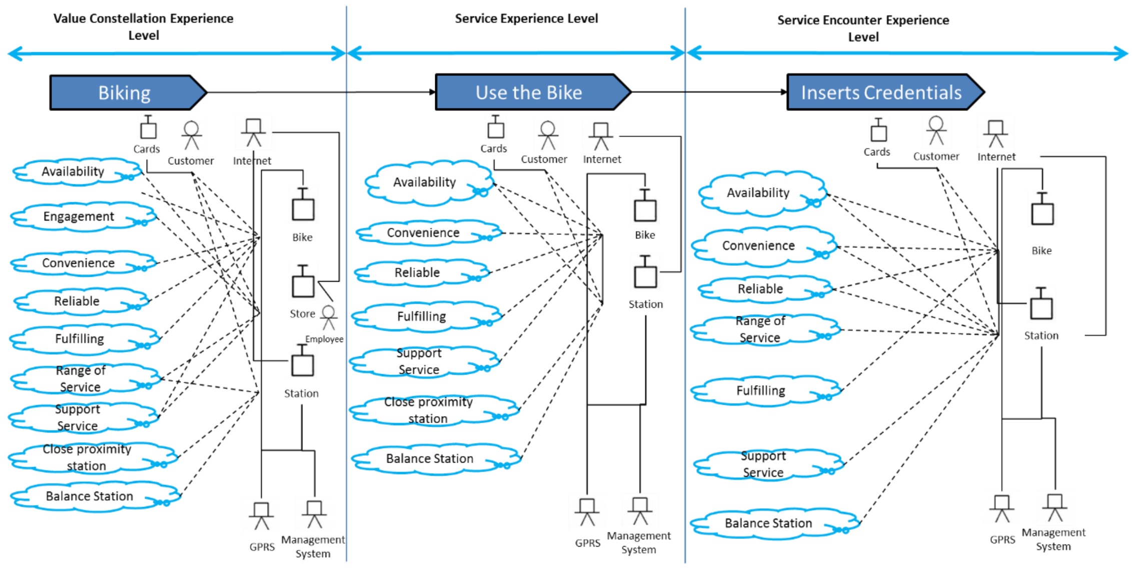

Figure 14 CEM Bike sharing system

In the CEM modelling as shown in Figure 14, it can be observed that for the biking activities, the CER's availability, engagement, convenience, reliable, fulfilling, range of service, support service, close proximity station and balance station are relevant. The artefact involved at this stage are the store, bike, cards and station. The actors are the users and employees while the system actors are the GPRS, Internet and Management System. On the second level, the CERs for the activity Use Bike are availability, convenience, reliable, fulfilling, support service, close proximity station and balance station. The artefact involved is the bike, station and cards and the system actors are the GPRS, Internet and Management System. For the last level, the CERs are availability, convenience, reliable, fulfilling, support service and balance station. The artefact is the bike and the station. The system actors remain the same.

4.9.3 Analysis

From the customer experience modelling drawn for Buga and the current bike sharing systems, the CERs most important are availability, reliable, convenience, fulfilling and also range of services. This tool gave a broad picture of understanding the factors that are important in the customer experience and give a preliminary idea of how the new system will be. It is good to note that this visualisation helps in understanding the interrelationship each CERs have with the system and give an overview of how to come up with technological solution in the latter phase of the service development.

4.10 Benchmarking

4.10.1 Just B

JustB is a bike sharing system developed by Miralago which formed part of the group ÓRBITA, the Portuguese biggest manufacturer of bicycles. The aim was to promote soft mobility in medium to large cities whereby a community of users from different social background can used the system. The main purpose is for short trips by residents and entities and for tourists. The advantages of the system are:

1. Easy to Install and Use;
2. Structural Flexibility;
3. Reduced Energy Consumption;
4. Innovative Leveling System;
5. Easy Urban integration.

The benefits are:

1. Economic Operation and Maintenance;
2. Does not Pollute;
3. Improves Population Health;
4. Reduces Traffic jam;
5. Contributes to greater energy efficiency in City transports;
6. Non Renewable Resources saving.

JustB consist of four elements. The bike park with a central post and docking unit having a communication system making use of such technologies as local WEB access, 3G or 4G and supported through a Central Post by a Router, UPS, Power Protection Systems and Dock Stations that contain the ATAS and Locks. They incorporate a patented leveling system in order to minimize any soil gap insuring a good bike docking. Also, a single card reader is used. The bikes are specially designed to be safe, reliable and comfortable and have embedded RFID making it identifiable. The system has an online management system that control in real time the status of bike station, include warning system in case of theft and collect operation data and provide statistics such as peak period of usage. The document flow are aggregated between management system, sales point, parks, bikes, users and cards that cater for better problem diagnosis and developing solutions remotely. Finally, the cards will vary with different subscription based on different rates, fixed, variable and progressive. Examples of cards are annual card, monthly card, temporal card, student card, and senior card and VIP card. The renewal of the card can be done at sales point and also in ATM connected to the management entity.

JUSTB is already present in some cities in Portugal including Águeda, Vilamoura, Vila do Conde and Viseu (justb.pt)

One Saturday, following a visit to Vila do Conde, it was observed that nobody was using the bike sharing system and all the station were deserted. Some casual people argue that the resident use it mostly during the summer and also, the price is quite expensive.

4.10.2 BikeEmotion

In 2011, BikeEmotion was founded with the mission of providing a bike sharing solution that allow easy locking and unlocking, traceability as well as flexibility. From 2014 onwards, BikeEmotion is the exclusive technological partner for Bewegen Technologies.

Main Features(bikeemotion.com)

1. Technologically Advanced
2. Adaptable
3. Cost Effective
4. Locatable
5. User Friendly
6. Flexible
7. Safe
8. Interactive

4.10.3 Bewegen

Bewegen took birth by proven international expert and is considered the next generation electric bicycle sharing solution. The bike is distinctively designed to offer the most ergonomic ride and is assisted by the pedelec motor that use a lithium battery. The bike offers the possibility to be located through GPS and has a screen mounted to give riding information to the user. The stations are solar powered, easily adapted to any locations and uses wireless communication. The management system is divided into back-office whereby every detail of the operations are meticulously analysed such as security alerts and the front-office that are involved with activities such as membership registration platform.

4.10.4 Social Bicycles

Social Bicycles comes from a startup founded in 2010 by Ryan Rzepecki in New York. The aim was to come up with a bike sharing scheme for cities that allow renting and unlocking of bicycles through a smartphone app. The system makes use of wireless technology to improve mobility. Reservation can be made from the web, mobile app or the bike itself. The users can share their activities such as distance covered, calories burned etc. From the operator side, capital cost is lower as all the technology are fitted on the bike and require less infrastructure for parking. The management system allows easy control of areas, hub locations, user profile, and bike usage and maintenance information. The scheme is designed for residents, municipalities, universities and corporates (socialbicycles.com)

4.10.5 Analysis

Table 4 summarises the system describes above.

Table 4 Benchmarking

Description	JustB	BikeEmotion	Bewegen	Social Bicycles
Usage				
Resident	✓	-	-	✓
Municipalities	✓	-	-	✓
Universities	✓	-	-	✓
Corporate	✓	-	-	✓
Technology				
GPS	✓	✓	✓	✓
Wireless station	✓	×	✓	×
Interactive interface	✓	✓	✓	✓
Pedelec	×	×	✓	×
Integrated System	×	×	×	✓
Real time management system	✓	✓	✓	✓
Safe	✓	✓	✓	✓
Solar Station	×	×	✓	×
Mobile App	×	×	✓	✓
Sharing info, statistics	✓	×	✓	✓
Membership cards	✓	×	×	×
Implemented	✓	×	×	✓

Key - donot know × not present ✓ present

The study undertaken in this chapter will help in designing the new services for SSB. The service specification as well as the other findings that address the needs of the customers will be translated into service offering in chapter 5.

5 Designing the new Services

This chapter relates to the design of the new service using the three steps of the Multi-Level Service Design (Patrício, Fisk, and Constantine 2011). For the design of the new service concept and the new service system, the current systems are first built as it act as a foundation to build the innovative service.

5.1 Service Concept

The how and the what of service design are defined by the service concept and it links customer needs with the organisation's strategy. Edvardsson et al. (2000) describe service concept as a way to describe, fulfil and achieve customer needs. Clark et al. (2000) define the service concept as:

1. Service operation: the way in which the service is delivered;
2. Service experience: the customer's direct experience of the service;
3. Service outcome: the benefits and results of the service for the customer and
4. Value of the service: the benefits the customer perceives as inherent in the service weighted against the cost of the service.

Indeed, designers are able to perceive better elements of service, verify them with customer needs and then design those elements when a service is broken down into the what and how. (Goldstein et al. 2002). The tools uses for designing the service concept is the customer value constellation (CVC). 'The CVC represents the set of service offerings and respective interrelationships that enable customers to co-create their value constellation experience for a given customer activity'(Patrício et al. 2013). The CVC can also be used to characterise a company as is service concept and with exploration, reconfiguration with innovative services can be performed (Patrício et al. 2013). The next section describes the service concept of Buga and the current bike sharing system. Then following the previous studies undertaken and to satisfy the needs of the customers, a new service concept is developed for the smart social bike.

5.1.1 Buga

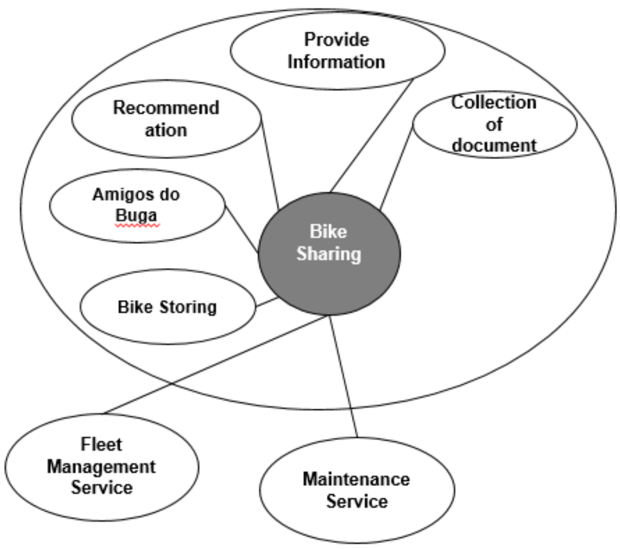

Figure 15 CVC Buga

Following the field study undertaken in Aveiro, the services involved in the Buga system is given in the customer value constellation diagram, Figure 15. The existing services identified are as follows:

1. Provide Information: The staffs of Buga are polite and are always helping customers. They are always very eager to explain to customers about the rules and regulation of the service and about its functioning.

2. Collection of documents: To be able to use the service, the customer need to give a document as safety which is returned to them after usage. The document can be any ID card such as resident card, student card or any social security card. In the case the bike is not returned, the card stays at the shop.

3. Recommendation: The staffs are always eager to help the users by giving indication about places to visit, and routes to take.

4. Amigos do Buga: A group of all the frequent users of Buga as members and organise activities. The group has around 1300 members.

5. Bike Storing: This service has the responsibility to keep the bike securely in a safe place such as to lock all the bike together in the parking lot after office hours and also in the shop.

6. Fleet Management Service: Ensure that there is bike available for usage especially during the peak time. In the case there is a need to call for more bikes from the store, the staff will ask for reinforcement.

7. Maintenance Service: Ensure the proper maintenance of the bike, especially those with baby seat attached. Verify and change the damage parts such as brake pads and used tyres.

5.1.2 Bike Sharing System

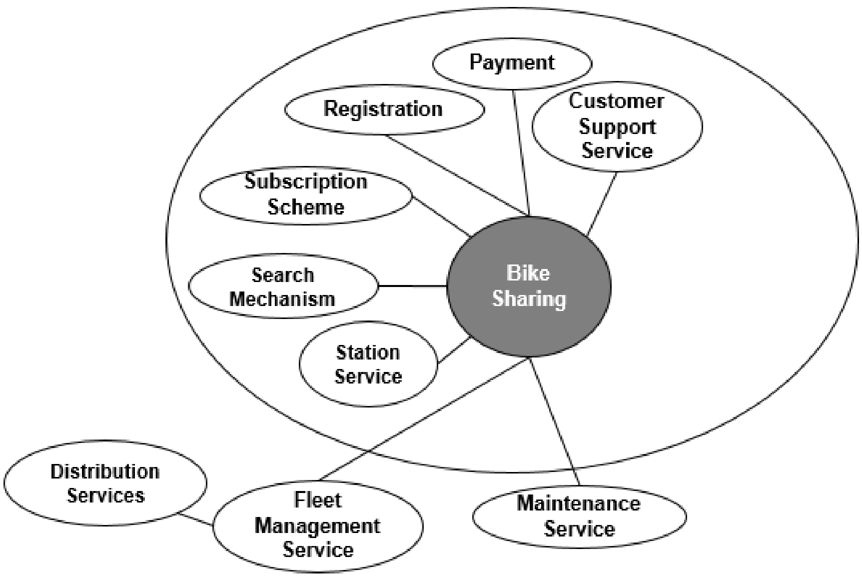

Figure 16 CVC Bike Sharing System

Following an intensive literature review as described in chapter two and an online exploration of the different bike sharing system currently available such as Bicing and Velib, the customer value constellation was drawn (figure 16) and consists of the following services:

1. Registration: Provide a platform to register to the bike sharing system, usually through a shop with interaction with an employee.

2. Subscription Scheme: users can choose the type of card they want to buy such as yearly, monthly, students, elders, tourists and even pay as you go.

3. Search Mechanisms: provide the assistance to users to search station, information kiosk or registration office, through mobile app or web interface.

4. Station Service: the place where the bike is locked and have card reader equipped that uses RFID technology to unlock bike. Some station are managed in real time giving the flexibility to manage the station parking space and bike availability.

5. Payment: Pay the service according to the subscription scheme that the user chooses. The payment can be carried out through credit card, debit card or cash.

6. Fleet Management Service: Ensure that there is bike available for usage by maintaining a balance station through the use of real time management through the internet.

7. Maintenance Service: Ensure the proper maintenance of the bike, by doing regular servicing and changing broken parts.

8. Distribution Service: This service is responsible to move around every station and fill in with bikes and make space for parking as well.

5.1.3 Smart Social Bike

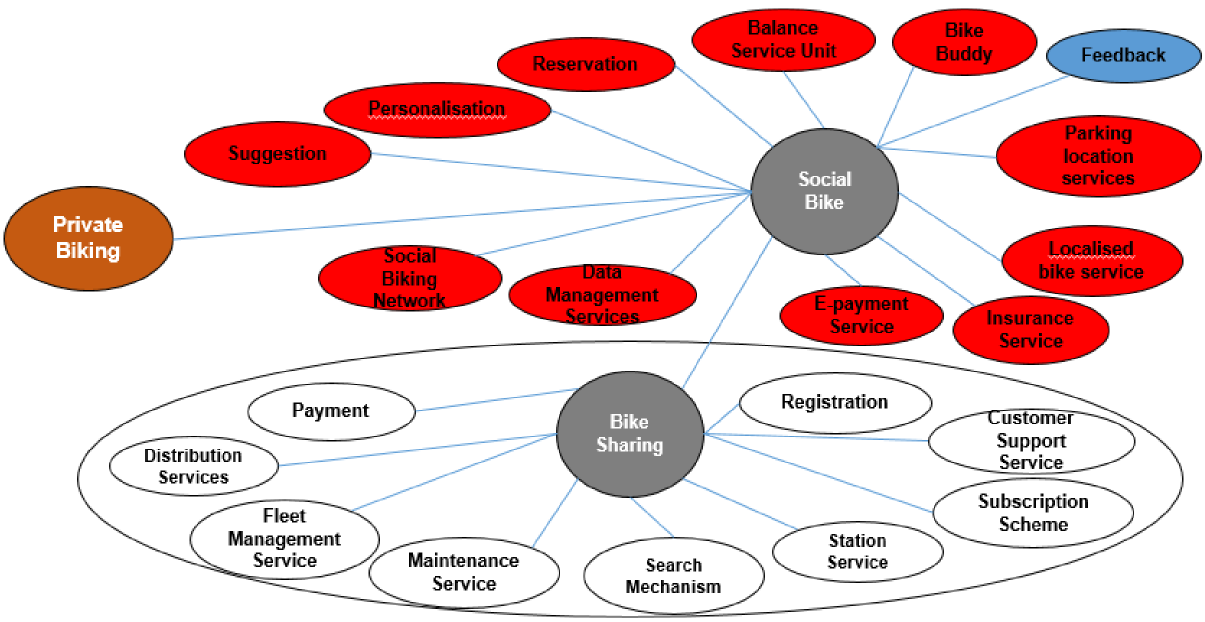

Figure 17 CVC SSB

The new service concept to be designed is built (red colour) on the current concepts in the markets and respond to the needs and problems from the customer and operators noted during the quantitative and qualitative study. Also, taking into consideration the new idea of making the bike social and having to integrate private bike in the ecosystem, the following innovative services (figure 17) are proposed:

1. Personalisation: allow the user to create his profile and manage his id by setting his preferences and notification he wants to see.

2. Social Biking Network: a platform that connect fellow users and allow them to share biking information, experiences while using the service.

3. Suggestion: users can provide best route, best place to visit, shopping malls with promo to different friends and also make some kind of challenges.

4. Reservation: user can keep bike for whole day without having to return the bike to a specific station. This leads to the need of having an intermediary lock on the bike.

5. Bike Buddy: can be virtual through smartphone or a person request from the social network – organise city tour, learn biking.

6. Parking Location Services: guide users to empty parking slots.

7. Localised bike service: Monitor bike displacement and is good for urban planning to determine station position.

8. Insurance Service: In case of Accident – Mobility Insurance (Mobi.Me).

9. E-payment services: partners with bank to pay online e.g MB net

10. Data Management Services: Analyse riding behaviour, identify pattern and preferences, provides maintenance report.

11. Balance Service Unit: cater for proper number of bike and parking slot availability.

12. Feedback: a service that will help in continuous improvement of the system. Create events that encourage people to give feedback on the system and make them willing to be interviewed.

13. Private Biking: this service allow private users to connect to the ecosystem through the use of a black box that provide same functionalities as with the bike sharing system.

5.2 Service System

The service system is designed using two tools namely the service system architecture (SSA) and the service system navigation (SSN). 'SSA defines the structure of the service system, providing an integrated view of the multi-interface offering and support processes across the service experience'(Patrício et al. 2013). They also defined the SSN as a tool that 'maps the alternative paths customers may take across different service encounters in the service experience'(Patrício et al. 2013). The SSA illustrates the main activities that a customer undertake. The column characterises the service interface in the frontstage and the support processes along with the technologies in the backstage. 'Each cell depicts a service task performed in a given service interface, which represents a service encounter or touchpoint' (Patrício et al. 2013). The matrix obtained allow the design team to identify the significance of backstage processes and technologies across the different activities performed by the customer (Patrício et al. 2013). The following section describes the SSA and SSN for Buga, current bike sharing system and proposes one for the smart social bike.

5.2.1 Service System Architecture Buga

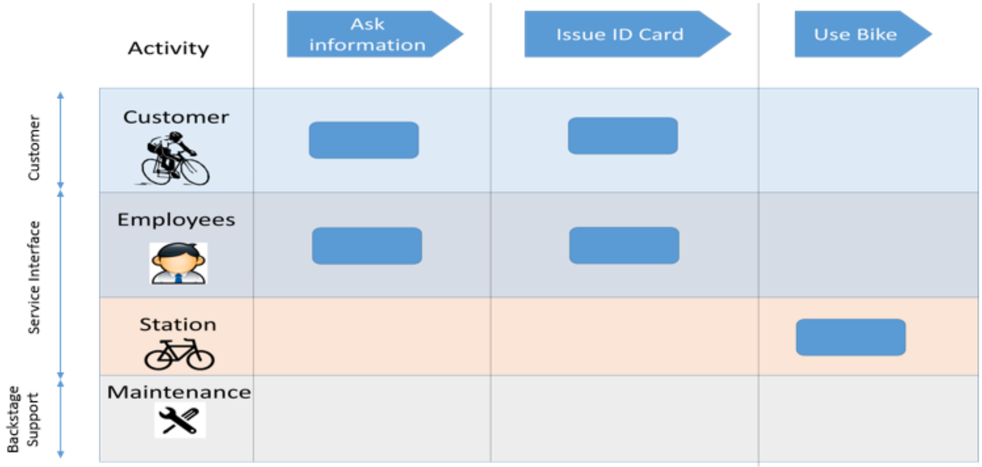

Figure 18 SSA BUGA

The service system architecture for the Buga system (figure 18) is simplistic. The employees and station form the only service interface that the system have and as backstage process, only the maintenance of the bike is performed. As mentioned in previous section, this system does not have any kind of technology associated with it. The body of the matrix shows that everything is done in the store until the user takes the bike.

5.2.2 Service System Architecture Bike Sharing Systems

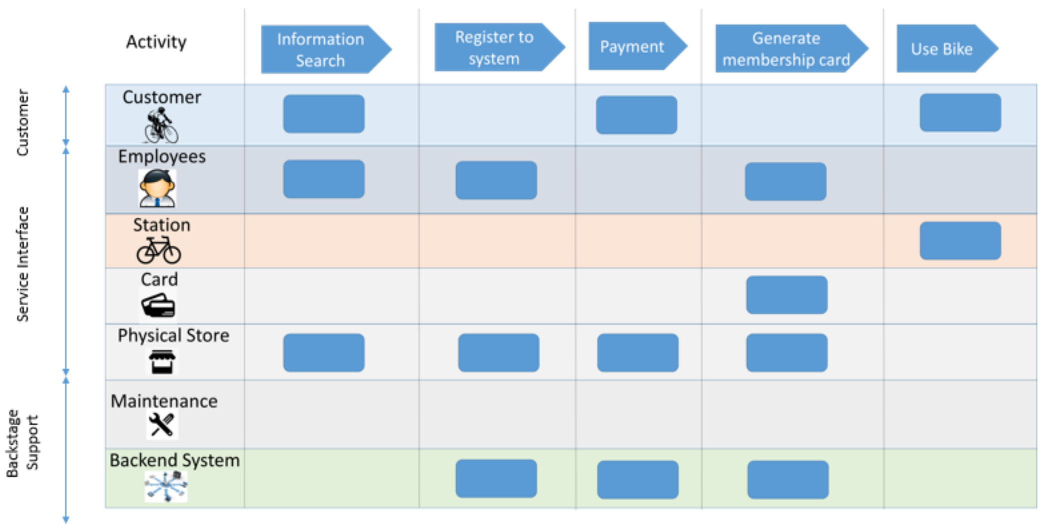

Figure 19 SSA Bike Sharing System

The SSA for the current bike sharing system is shown in Figure 19. As service interface, the current system has the employees, station, physical store and the membership card. The backstage process comprises of the maintenance service which is responsible for the proper running of the bike and the system. The backend system is responsible for managing the service in real time knowing the availability of bike at each station. The body of the matrix shows that prior to using the bike, the preliminary activities are mainly carried out in the physical store.

This gives an insight that new system to propose, can decentralise the activities and make other channels available to perform it.

5.2.3 Service System Architecture SSB to be

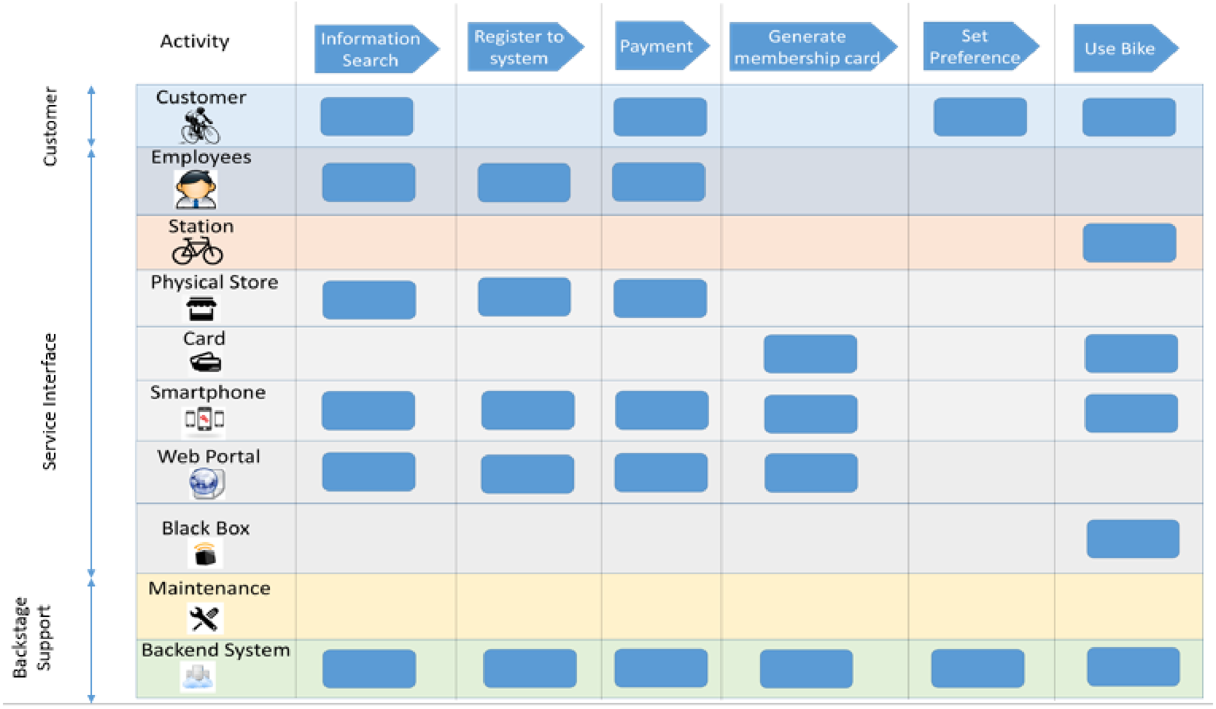

Figure 20 SSA to be

The SSA for the new service is drawn (figure 20) after analysing the current systems and also taking into consideration the second part of the quantitative study whereby the new idea was proposed to the users. The service interface in the new proposal extends to include smartphone, web portal and a black box. The smartphone and web portal will help reduce the burden on the physical store by allowing to register and pay the system. Also the user will have the ability to use an e-card to unlock the bike instead of the traditional card. The black box will synchronize with the smartphone of the user and work according to the preferences set by the user with the app. The backend system which is operable by Mobi.Me provides a cloud service responsible for supporting the activities of the new service. To cater for the new idea of having a social bike, the activity set preferences is added as it will allow the user to choose what he/she wants from the system in terms of feedback from the riding pattern, the social behaviour and notification from partners.

5.2.4 Personas

Personas is a fictional character that mimic potential users by assuming the segment they represent in terms of needs, habits, cultural, social and demographic backgrounds (servicedesigntools.org). Two personas, Anvar and James have been chosen that represent the segment identified previously. Anvar is a 21 year old Erasmus student from Liverpool. He came to Portugal as part of an exchange program and uses a bike every day to go to faculty. He also love biking and on weekends likes to ride along the Douro river. James is a 35 year old engineer. He likes biking and most of the time he goes to work on bike.

5.2.5 Service System Navigation

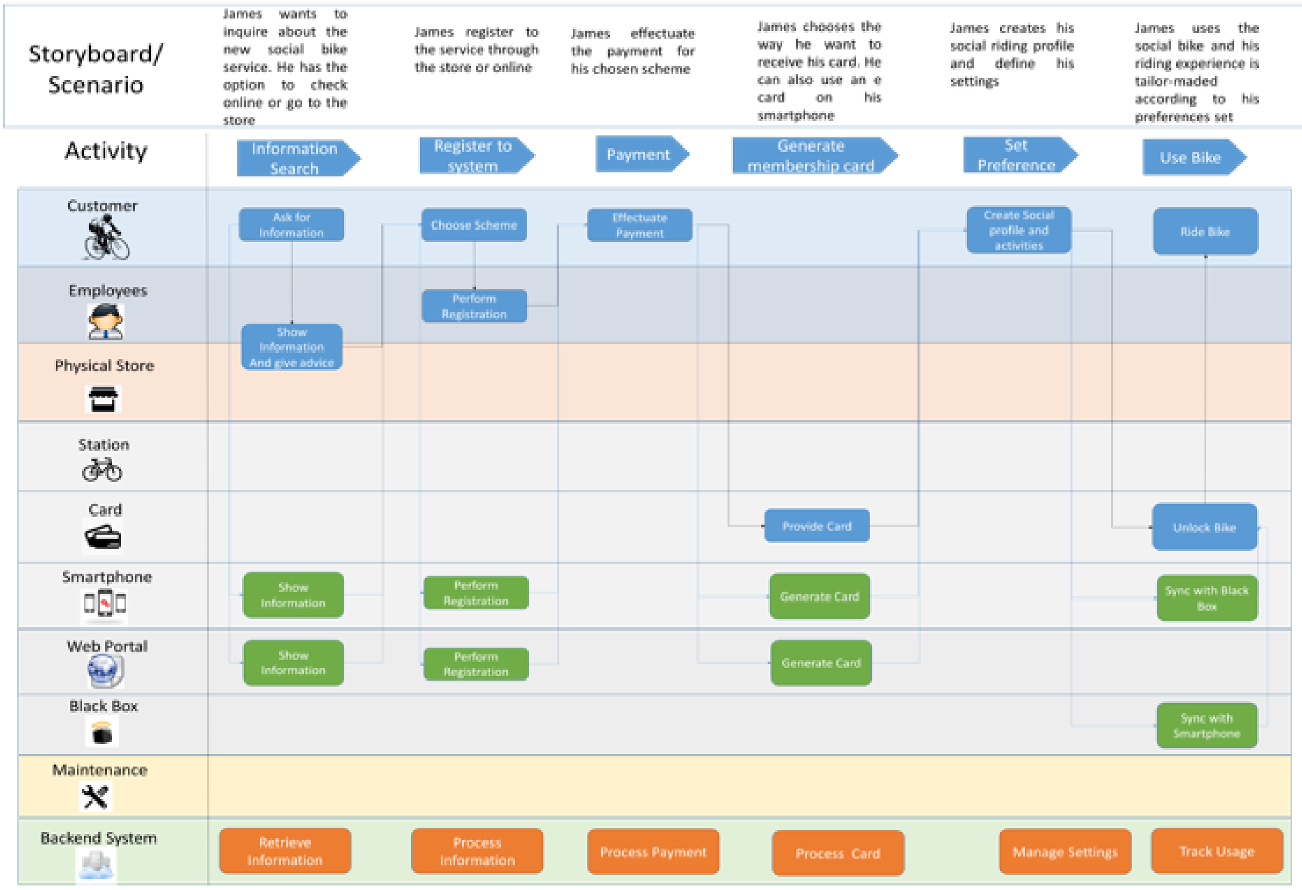

Figure 21 SSN for SSB

'SSN enables mapping possible customer journeys across service interfaces and explicitly designing the necessary links between service interfaces to assure a smooth experience across service encounters' (Patrício, Fisk, and Constantine 2011). Figure 21 depicts the SSN for the new service and a scenario narration is included on top. The SSN depicts the journey for a user and in this case James, the persona describes in section 5.2.4. James wants to inquire about the new social bike service. He has the option to check online or go to the store. James register to the service through the store or online. The payment for the chosen scheme is carried out and he chooses the way he wants to receive his card. He can also use an e card on his smartphone. James creates his social riding profile and defines his settings. James uses the social bike and his riding experience is tailor-made according to his preferences set. The next section goes deeper into the touchpoints of the new service using the service blueprinting techniques.

5.3 Service Encounter Design

Bitner et al. (2000) define service encounter as the instance where customers interact with a firm through different interface that the firm offers (Bitner, Brown, and Meuter 2000). Zomerdijk and Voss (2009) argue that in the jargon of service design, service encounters are touchpoints and it is the responsibility of the service designers to address the interaction setting, interaction process and the role of the actors (Zomerdijk and Voss 2010). The Service Blueprint can be defined as a schematic representation of the different activities involved in a particular process. The diagram depicts the different actors involved in the process, their front stage and backstage involvement in the different places.

5.3.1 Service Experience Blueprint

5.3.1.1 CREATE SOCIAL PROFILE

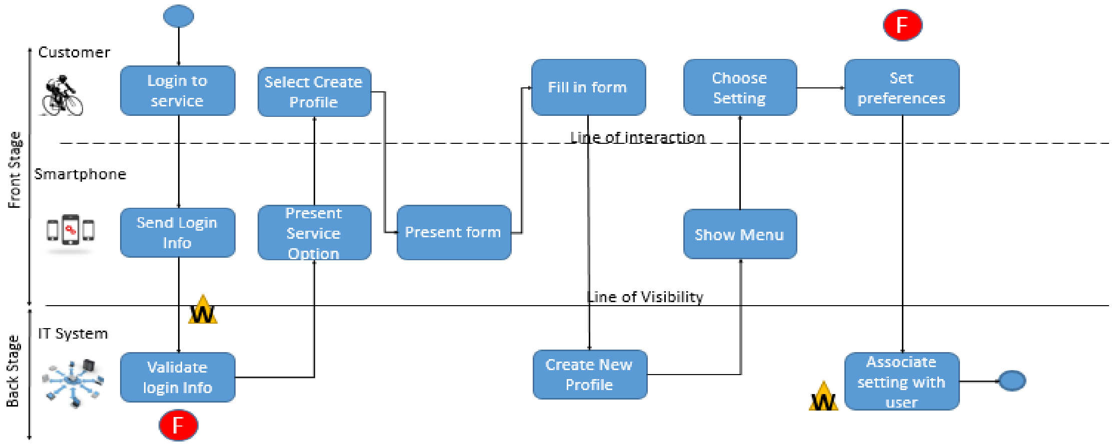

Figure 22 SEB creating profile

Figure 22 describes the creation of the social profile by the user once he is registered to the system. He uses his login credential received and access the social profile. He has the ability to define what he wants from the service by setting his preferences. The set preferences allow the user for instance to receive notification from a certain partners and track his riding behaviour. The failure points can result due to the system being unable to process the influx of data at the same time.

5.3.1.2 USING THE BIKE

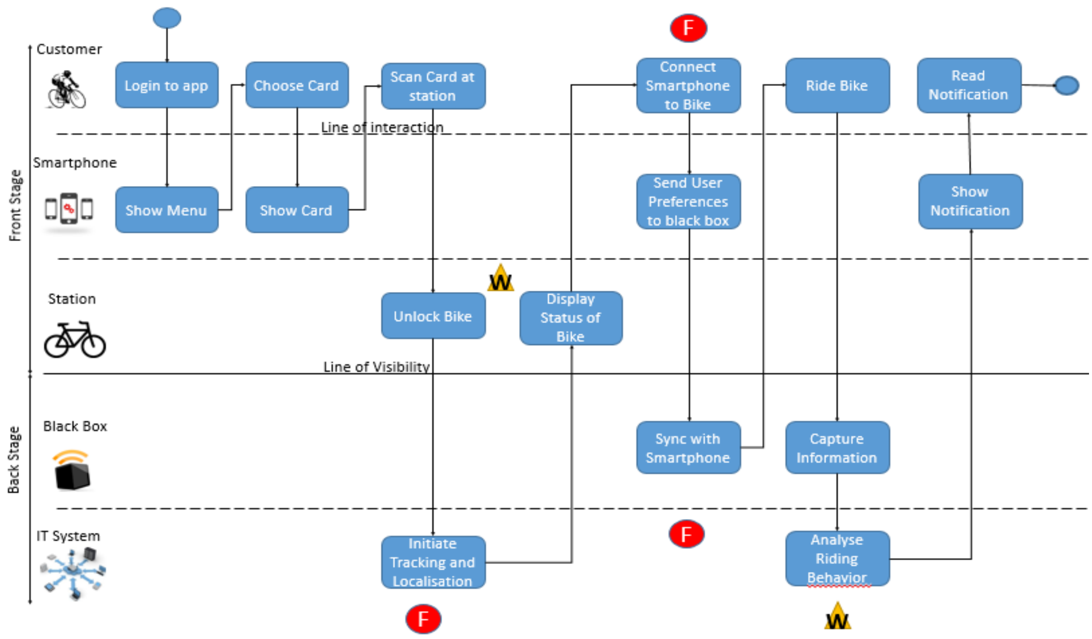

Figure 23 Using the Bike

Figure 23 describes the usage of the system assuming that the user will use the e-card. The user logins on the mobile app and chooses the option card. He scans the card at the station and unlocks the bike. Then he connects his smartphone with the bike. The black box on the bike synchronises with the smartphone and reads the preferences of the user. During the ride, the black box will only capture information as set by the user and sends the appropriate notification. Note that, the system will track the positioning of the bike. The failure might arise during synchronisation due to network problem. The analysis of the riding behaviour might take some time due to the influx of information to process according the need of the user.

5.4 Actor Network Mapping

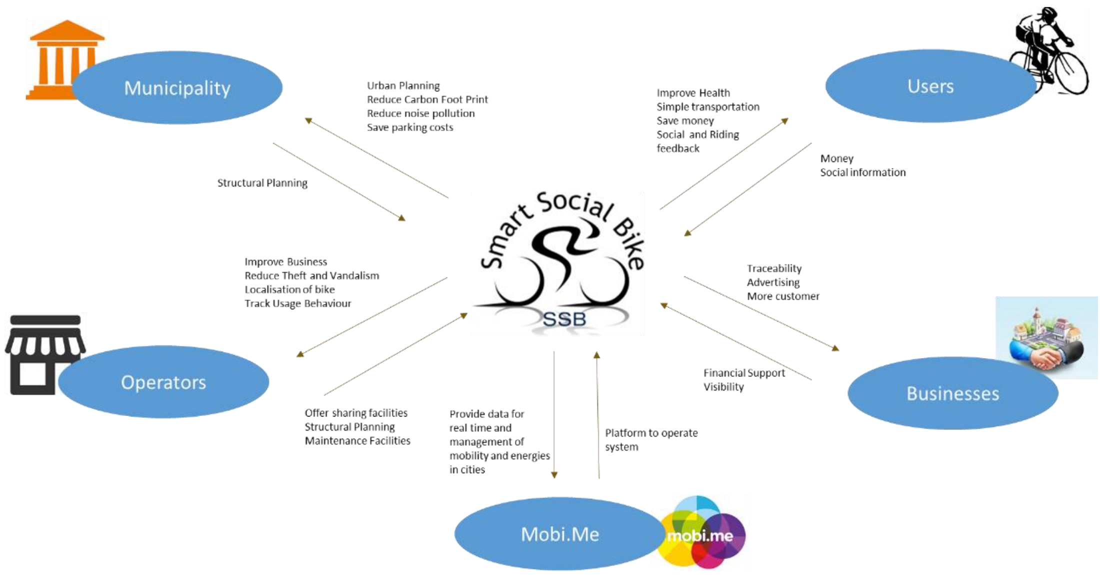

Figure 24 Actor Network Map for SSB

An operative paradigm is defined as 'a methodological toolbox that supports the generation of solutions to a concrete problem, on the basis of a certain methodological approach' (Morelli and Tollestrup 2007).

Three main section of tools and methods that help to generate new PSS are according to (Morelli 2006b):

1. The analysis and interpretation of the context;
2. The development of the system; and
3. The representation and communication of the solution

Morelli and Tollestrup (2007) argue that new representation and communication techniques have the responsibility to give information to different stakeholder. 'The toolbox designers need in order to operate in the new context to include representation techniques for communicating the new solutions' (Morelli and Tollestrup 2007):

1. **in all the phases** (the analytical as well as the design phase, the technical phase or the final rendering),
2. **with all the actors** involved (technical people as well as final actors); and
3. **in different scales** (detailed representation as well as overall view).

One such technique is the actor network mapping that depict the network of actors and components in the system. The focal point is the on roles, grouping and relation. Several maps are yielded through diverse point of view. Morelli and Tollestrup (2007) argue that 'a network map could be used to represent an existing system or to generate models of a new system' (Morelli and Tollestrup 2007).

Figure 24 depicts the actor network map for the Smart Social Bike. The actors for SSB are the users, municipality, businesses, operators and Mobi.Me. To be able to implement SSB, the municipality need to provide the appropriate structure such as defining the places that will serve as stations, and making sure that the infrastructure that the system will need are available such as internet, power supply and lighting. On the other hand, SSB provides a platform to help municipalities in Urban Planning. Traditional bike sharing system do allow urban planning but is only limited to the determination of station positioning. SSB goes a bit further as it will allow municipalities to see zones of interest to users through the use of heat maps. For instance, the city of Porto has been voted best European City of 2014. Let's assume that the municipality is embarked on sustaining this award for more years to come. Through SSB, monitoring the usage and behaviour of tourists, they will see the places of more interest to tourists. By identifying these points, they can enquire about the services and things that make these places popular. For example, an enquiry may yield that near the bridge a lot of people visit the place to get a nice view of Ribeira. However, there are some empty old building presents and these might be used to create a museum show casting the experience of building that bridge long time ago. Also, an electric bike allows the reduction of carbon foot print of a city and help reducing congestion and traffic thereby decreasing parking costs. Indeed, SSB will help improve the business on the operator side of view as it will help reduce two main problems such system faces, namely, theft and vandalism. The system will have a unique identifier which will be localised through a GPS. The operators will also have information on the users and track their usage behaviour. Being a smart bike with embedded sensors that do a self-assessment of its status, any act of vandalism will immediately be prompted to authorities. On the contrary, the operators will provide the necessary facilities such as maintenance, subscriptions management.

Mobi.Me will provide the platform to operate the system and SSB will help by providing data for real time and management of mobility and energies in the city. For the users, the experience will completely change. SSB will allow users to track meticulously their riding behaviour and combine it with their social life. The system will provide a safe and fast mean of transport which senses the environment according to the wish of the users. The black box incorporated in the bike will identify its users through their smartphone and tailor-made their ride according to their wish. In return, the users brings revenue to the system as well as insightful information that help to improve their experience. For example, if James likes football and there is a promotion in the store of a football team, he will get a notification. Businesses such as restaurants, shopping mall and cinemas for instance will provide financial support in terms of advertisement and also make SSB visible. On the other hand, SSB will help increase their customer base and will allow them to trace the origin of the clients. For instance, if Company V inject X amount of money in SSB, and they see that their customer base is increasing due to SSB, they can invest more and provide more benefits to users of SSB. Other innovative ideas can add on to SSB such as using a particular station as an outdoor spinning class and a gym can become a partner. This idea will further challenge the product design to have an adaptive station. The Business Model of SSB was drawn using the Business Model Canvas proposed by (Osterwalder and Pigneur 2010). The Canvas is given in appendix E and gives an idea of how to manage and make SSB operable.

6 Social Internet of Things Architecture

This chapter describes the requirement elicitation phase in order to attain the objectives of the project which is to design an architecture that work under the Social Internet of Things paradigm and to define the requirements to do so. The requirement elicitation steps are used(Pohl 2010). This section addresses more to the developer who will be responsible for the design and implementation phase of the project.

6.1 Source of Requirements and Stakeholder

The sources of the requirements can be seen in table 5.

Table 5 Source of Requirements

No.	Source	Role	Priority
1.	Stakeholders	People involved in the project and system	High
2.	Literature study	Study about state of the art of SIOT	Medium

Stakeholder can be defined as the people that are involved in a project and are responsible for its design, implementation and operation. The stakeholder need to be properly defined at the development stage and the service usage stage.

The stakeholder analysis can be seen in the following table 6.

Table 6 Stakeholder Analysis

No.	Stakeholder	Interest in the Project/ Service	Importance	Influence	Strategies for Involvement
Project Development					
1.	Project Supervisor (CEIIA)	Give information about the system and receive the built system	High	High	Consultation, discussion, and regularly meeting
2.	Requirement Engineer (FEUP Intern)	Analyze and develop system requirement	Medium	High	Discussion and meeting
3.	System Engineer (Mobi.Me)	Develop and build the system	Medium	High	Give the requirement documentation report
4.	Cloud Administrator (Mobi.Me)	Responsible for cloud data storage management	Low	Medium	

No.	Stakeholder	Interest in the Project/ Service	Importance	Influence	Strategies for Involvement
5.	Market Analyst	Analyze the target market and strategy to publish the service system	High	Medium	-
Software System Usage					
1.	Bike Rider	Use the bike for their convenience	High	Low	-
2.	Service administrator (Mobi.Me)	Manage the service infrastructure	High	Low	-
3.	Service Operator	Manage service subscription and payment	High	Low	-

6.2 Use Case Diagram

From the goals defined in appendix E, use cases are defined for each user and consist of 32 use cases with four actors, the general user, the operator, the administrator and cloud provider as external system. The use cases are given in appendix F.

6.3 Actor Definition

Actors who are involved in the system is given in the following table 7.

Table 7 Actor Definition

No	Actor	Actor Code	Description
1	User	AC-01	Person that will use the bike sharing system. They can be students, tourists, workers and residents
2	Operators	AC-02	People that provide the service to users. They can be municipalities or advertising companies
3	Administrators	AC-03	People responsible for the proper running of the system. Mobi.Me engineers.
4	Cloud Provider	AC-04	Mobi.Me system that provide the storage and software tool management service in the cloud.

6.4 Use Case Description

Use Case UC-21 is chosen as it is not illustrated in the service experience blueprint.

Use case name	:	Manage the service
Use case code	:	UC-21
Brief Description	:	The operator logins in the system to check the daily operation. He needs to ensure the proper running of the service. He checks the status of the bikes and stations and any repair that need to be performed
Actor	:	Operator
Trigger	:	The operator need to prepare his activities
Pre-condition	:	Operator is registered and already logged in the system. System has been activated and interface is displayed
Post-condition	:	The service is managed properly

Table 8 Scenario Description Manage Service

Actor's action	System's reaction
Normal Scenario (SC-01-01): Manage the service	
	1. Display the main menu
2. Choose Station Menu	
	3. Show Station Menu The Menu consist of map of the city and status of each station
4. Choose a particular Station Y	
	5. Display the detail about the station
6. Check the number of bike and parking	
7. Click notification	
	8. Display the notification menu
9. Choose advice nearby users	
	10. Send notification to nearby users to fill in empty space at a station Y
Alternative Scenario 1 (SC-01-02): Choosing customer support	
1.a. Choose Customer Support	
	2.a. Show customer support menu
3.a. Choose Complaint section	
	4.a. Display complaint section
5.a. Choose a complaint	

Actor's action	System's reaction
Normal Scenario (SC-01-01): Manage the service	
6.a. Solve the complaint	
	7.a. Send notification to user
Alternative Scenario 2 (SC-01-03): Choosing Repair and Maintenance	
1.a. Choose repair and maintenance menu	
	2.a. Display repair and maintenance menu
3.a. Choose list of bike	
	4.a. Display list of bike with status
5.a. Choose red icon coloured bike	
	6.a. Display detail of the chosen bike
7.a. Analyse the problem	
8.a. Assign maintenance team for the repair	
	9.a. Send notification to the maintenance personnel

6.5 Architecture

The architecture diagram (figure 25) is designed based on the SIOT architecture explained in section 2.5. The three main actors that interact with the system using either a laptop or a mobile device are the users, operators and administrator which are connected to the data warehouse provider in the service cloud of Mobi.Me. The web service-based component which provide the bike sharing system consists of 6 main components which are connected by interface component. The components are separated in the system so that developer can reiterate the development from existing service components and it will be easier to update or maintain each components. The 6 components are:

1. The application layer, comprise of desktop user interface for registration, administration, social biking network and APIs for the link to 3rd parties.
2. Component layer, responsible for the SIOT functioning and comprise of profiling, owner control, ID management, Relationship Management, Service Discovery, Service Composition and Trustworthiness management.
3. Data layer consists of semantic, ontologies to converge the data receive into the same language, data processing unit, data access & setting, data warehouse manager, cloud service manager and business intelligence and decision support module.
4. Sensing layer responsible to capture data and consist of user preference unit, data monitoring unit and data collection unit.
5. Crosscutting security component, controlling account management and consists of account and access control unit.
6. Crosscutting operation component, controlling the business model management consist of subscription manager, billing & payment, fleet management, maintenance management, service

usage monitor, client personalisation, distribution management, customer support service and social network management.

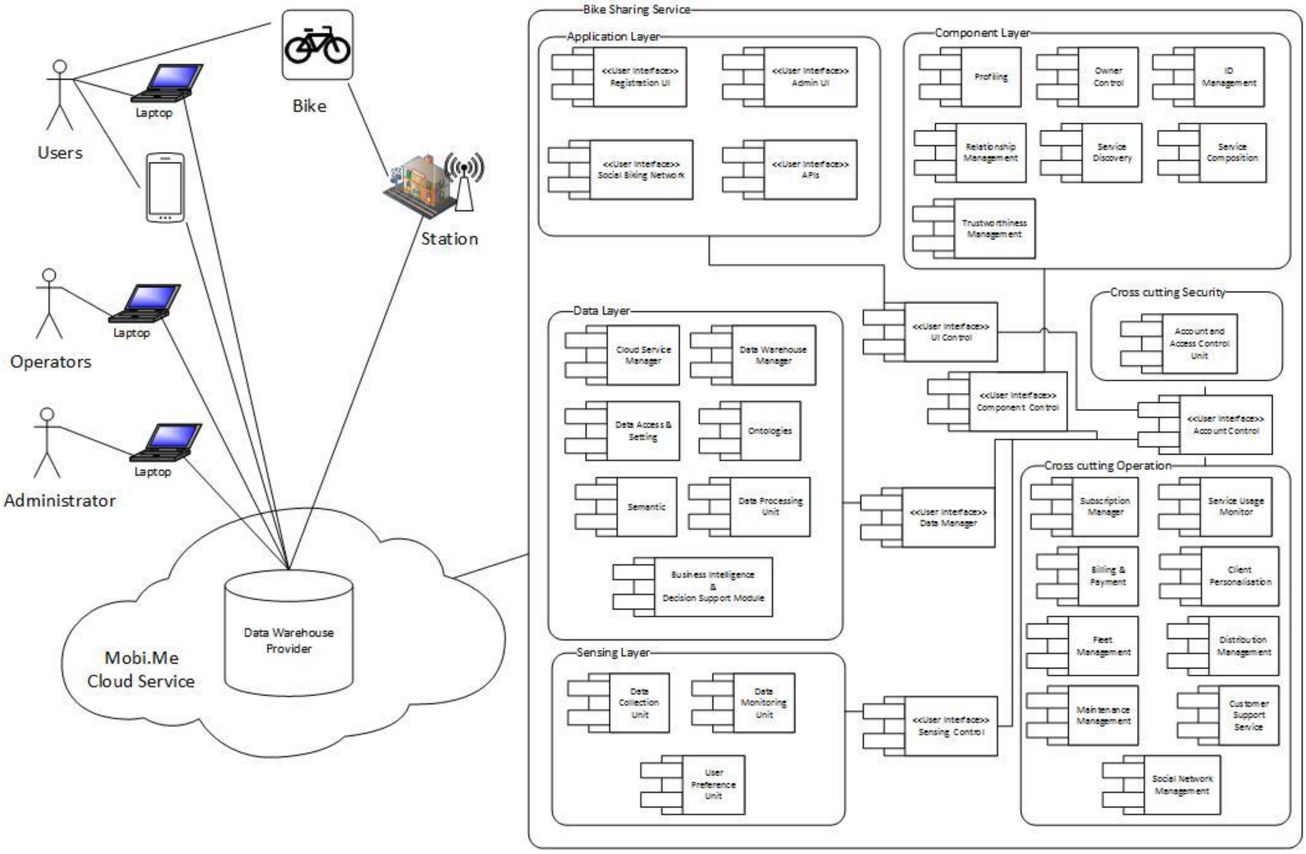

Figure 25 System Architecture for SSB

6.6 Requirement Identification

The web service to be developed for SSB, need to fit in the current Mobi.Me platform and provide the new service of social bike sharing whereby the bike are socially connected in order to improve user experience, businesses and gather useful information. The system for SSB will have three major part functions, data input, data processing and output. Data inputs starts from the moment a user register to the system till he finish using a bike. The inputs are his information, his preferences he sets, the way he rides a bike, the benefits he uses from the system. The data processing includes requirement that validate and analyse the data. The output includes requirement that present the processed data into meaningful information for the user, operators and partners. The functional and quality requirement are given in appendix D and E and the following criteria (table 9) is used to assign the priority.

Table 9 Criteria Definition

Priority	Definition	Symbol
Essential	The system cannot run without fulfilling this requirement	E
Conditional	Implies enhancing the system	C
Optional	Implies may or may not be worthwhile	O

7 Conclusion and Future Work

This research proposed the design of a Product Service System under the Social Internet of Things. The project intended to answer two main objectives, firstly offering a set of services for a so called smart social bike that CEIIA want to develop. Secondly, it is important to explore how to include concept from product service system in the service design process. It was crucial to understand the customer experience as a first step so as to grasp their needs and design a service accordingly. The Social Internet of Things being a new paradigm, it was important to understand the architecture and adapt it to the context of the product service system to be designed. The research questions have been revisited and are given as follows:

RQ1. How to integrate the concept of PSS in the design of the new service for the smart social bike under the 'Social Internet of Things Paradigm'?

The Multi-level Service Design was used in order to design the service in a systematic way. New services were ideated through the Customer Value Constellation, the Service System Architecture and Service System Navigation were drawn in order to understand which actors, service interface and technologies are responsible during the different activities of the customer journey. After that, the service encounters are illustrated through the use of service blueprinting. Indeed, there was a need to go beyond the touchpoints to show what value is being given to the different stakeholders during a particular activity. The actor network mapping helps to bridge this gap by showing what is offered to the different stakeholders during the usage of the service. This process also helps in the identification of requirements that is important to make the system operable.

RQ2. How to design an architecture to support such new Product Service System?

The SIOT architecture gives the main components of what is required to make an object social. However, it misses the operations components that is what is needed to make such architecture work for a given case. In the current context, through the ideation process of Customer Value Constellation and the analysis of the service system architecture, it was possible to come up with a list of operation modules that is added to the SIOT. This architecture will eventually help the designers to identify the technologies that will be required and also give them an insight on how to properly design the product to accommodate such technologies and help complement the service system architecture.

Indeed, the research has limitation and one was adapting the SIOT architecture in the new product service system. As such literature is limited on the SIOT and more intensive study need to be carried out in order to validate the architecture proposed for SSB. The architecture is very important as it gives the base to identify the technology needed and how the product design will adapt to accommodate the technology.

The next step in the project is to validate the requirements identified with the stakeholders. Then a near to real life prototype that have the features proposed should be develop and test on a big scale (within a town) with the customer segments identified. A software need to be develop as well to ensure the proper management of SSB. Feedbacks obtained from test can then be used to improve the concept before the launch SSB. Also, other technique of the product service system can be used at that stage such as time sequence and daily routine diagram (Morelli and Tollestrup 2007) to assess capacity management. This helps the operator offer new services at off peak time. Indeed, the business model can be improved to better fit the context.

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Appendix A Interview Questions Users of Bike Sharing

1. Section One
2. Age
3. Gender
4. Occupation
5. What is your experience with the bike?
6. Rate the component of the service on a scale of 1 to 5?
   Station
   Bike
   Info Kiosk
   People
7. What improvement can you suggest to the current system?
8. Do you have your own bike? Do you prefer your own bike?
9. How many times have you used the bike sharing (BUGA)?
   Section Two
10. The following description of Smart Bike was narrated to the interviewees following which the questions are asked. A smart bike can be defined as one that share their location to a main server using wireless technology and guide the user through a comfortable ride.
11. Suppose I'm selling a black box and using this black box, you bike becomes a smart bike. Would you buy it?
12. Suppose that all the current BUGAs are replaced by smart bike. Do you think it is a good alternative?
13. Do you think that connecting your smartphone to a bike is a good idea so as you can record exchange information?
14. Do you think that a smart bike will help reduce the risk of theft and vandalism?
15. What is your opinion about gathering data on riding pattern such as gear changes?
16. Do you think it is a good idea to be able to localise a bike through GPS?

Appendix B Interview Questions for Operator

1. Describe the business and industry
2. Where did the opportunity for this business come from? Opportunity (challenge and solution)
3. Is there any requirement from the municipality of Aveiro?
4. What is the value proposition?
5. How does the system works?
6. Fleet and station size?
7. What major problems faced?? Robbery in numbers?
8. How these problems are being solved?
9. What are the growth plan?
10. What about the team? Size, age? Key resources?
11. Who are your partners?
12. What channels you used to reach your customer?
13. What are your key activities?
14. Who are your customer? What relationship you have? Any crm? Retention rate?
15. What are your cost structure? Maintenance?
16. What activities do you outsource?
17. What are you revenue streams?
18. Investment Cost?
19. Are you happy with your current business model?
20. Are there any project related to Smart cities?

21. What is the company doing in terms of customer experience?
22. Any software for the management of the fleet of bikes?
23. What is the plan for the management of the fleet of bikes.
24. Do user fees cover operational cost.
25. What is the insfrastructure available in the city to sustain the bike sharing?
26. What are the % of bike being use in the city as compared to other mean of transport?
27. What are the barriers in utilizing the bike in Aveiro?
28. What is the importance of bike sharing in Aveiro?
29. What is your personal opinion on bike sharing?
30. How does the system impact the overall transportation system?
31. Is the system sustainable?

Appendix C Questionnaire Sample

Survey on Bike Sharing Systems

Dear Participant, I'm a Student from the Faculty of Engineering of the University of Porto and is undertaking a survey on Bike Sharing System as part of my master thesis. Grateful if you can please fill in the questionnaire. Thank you very much.

* Required

1. **Age ***
   Mark only one oval.
   - 16 - 24
   - 25 - 33
   - 34 - 42
   - 43 - 51
   - 52 - 60
   - > 60

2. **Gender ***
   Mark only one oval.
   - Male
   - Female

3. **What is your educational level? ***
   Mark only one oval.
   - Primary School
   - Secondary School
   - Bachelor
   - Post-Graduation
   - Master
   - Doctorate
   - Other: ____________

4. **What is your occupation? ***
   Mark only one oval.
   - Student
   - Employed
   - Unemployed
   - Retired

5. **What is your nationality? ***

6. **Do you have your own bike? ***
   Mark only one oval.
   - Yes *Skip to question 7.*
   - No *Skip to question 9.*

Survey on Bike Sharing Systems

7. **What is the frequency of use of your bike? ***
   Mark only one oval.
   - Everyday
   - Frequently (more than 3 times a week)
   - Rarely (less than 3 times a week)
   - Other: ____________

8. **What is the reason for using the bike? ***
   Check all that apply.
   - Commuting
   - Tourism
   - Leisure
   - Sport
   - Health
   - Other: ____________

Survey on Bike Sharing Systems

9. **Have you heard of Bike Sharing System? ***
   Mark only one oval.
   - Yes
   - No

10. **Have you use a bike sharing system? ***
    Mark only one oval.
    - Yes *Skip to question 11.*
    - No *Skip to question 35.*

Survey on Bike Sharing Systems

11. Which of the following bike sharing system have you used? *
Mark only one oval.
- BUGA (Aveiro, Portugal)
- Bicing (Barcelona, Spain)
- Bicincintta (Italy)
- Velib (Paris, France)
- CitiBike (New York, USA)
- Other: ____________

12. What is the reason for using the bike sharing system? *
Check all that apply.
- Commuting
- Tourism
- Leisure
- Sport
- Health
- Other: ____________

13. If you choose commuting, what distance in km did you cover?

____

14. What is the frequency of usage of the bike sharing system? *
Mark only one oval.
- < 10 times a month
- Between 10 to 20 times a month
- > 20 times a month

15. Do you use other mean of transport along with the bike? *
Mark only one oval.
- Yes
- No

16. If yes, which one?
Check all that apply.
- Car
- Bus
- Metro
- Train

17. How you became aware of such a system? *
Mark only one oval.
- Internet
- Radio
- Tv
- Newspaper
- Other: ____________

18. Is the service information available on the web or a mobile app? *
Mark only one oval.
- Web only
- Mobile app only
- Both
- Don't Know

19. Have you use the app or the web? *
Mark only one oval.
- Web only
- Mobile App only
- Both
- None

20. What are or were the reasons for you to use this type of service? *
Check all that apply.
- Preserve Environment
- Leisure
- Fun
- Cheap
- Health
- Convenience
- Readily available
- Quick mean of transport
- Other: ____________

21. **What are the main problems you encountered during the usage of the system? ***
Check all that apply.

- [ ] Stations are very far from each other
- [ ] Station full when returning bike
- [ ] Station Empty
- [ ] Narrow bike lane
- [ ] Too much traffic
- [ ] Vandalism
- [ ] The city is not well adapted for bike sharing
- [ ] Lack of Information on the service
- [ ] Bike not properly maintained
- [ ] No safety measures
- [ ] Other: ____________

22. **What are the good aspects of the service? ***
Check all that apply.

- [ ] Price
- [ ] Ease of Use
- [ ] Accessibility
- [ ] No worry about maintenance of bike
- [ ] No worry about theft
- [ ] Readily available
- [ ] Efficient mean of transport
- [ ] Other: ____________

23. **Rate the following components of the service on a scale 0 to 5 ***
With 1 being very bad, 3 Good and 5 excellent
Mark only one oval per row.

	1	2	3	4	5
Web Interface	◯	◯	◯	◯	◯
Mobile App	◯	◯	◯	◯	◯
Station	◯	◯	◯	◯	◯
Information Kiosk	◯	◯	◯	◯	◯
Bike	◯	◯	◯	◯	◯
Customer Support Service	◯	◯	◯	◯	◯

24. **Describe your user experience with the bike sharing system? ***
Please tell us your level of satisfaction about the service

____
____
____
____
____

25. **Would you use the service again? ***
Mark only one oval.

◯ Yes
◯ No

Survey on Bike Sharing Systems

This section is to study the possibility of using a smart bike instead of the traditional bike in Bike Sharing System. A smart bike can be defined as one that share their location to a main server using wireless technology and guide the user through a comfortable ride.

26. **How is a smart bike sharing system a better alternative to the current system?**
Check all that apply.

- [ ] Give better riding experience
- [ ] More safe
- [ ] More intelligent in tracking traffic pattern
- [ ] Prevent loss of bike
- [ ] Identify empty station autonomously
- [ ] Other: ____________

27. **On a scale of 1 to 5, do you think it is a good idea to establish communication between your bike and your smart devices?**
By communication we mean that the bike exchange information such as location, gear shift, speed and seat position for instance. And the smart devices help the bike identify its user.
Mark only one oval.

	1	2	3	4	5	
Very Bad	◯	◯	◯	◯	◯	Excellent

28. **Please state why you choose the rating or add any comment.**

____
____

29. **On a scale of 1 to 5 how would a smart bike be a good solution to address the following issues?**
1 - Very Bad, 5 - Excellent
Mark only one oval per row.

	1	2	3	4	5
Theft					
Vandalism					
Empty Station					
Full Station					

30. **Any comment.**

31. **On a scale of 1 to 5, what is your opinion on having the possibility to localise yo bike through your smart devices?**
Mark only one oval.

	1	2	3	4	5	
Very Bad						Excellent

32. **Please state why you choose the rating or add any comment.**

33. **On a scale of 1 to 5, what is your opinion on having a bike which have the following features and send these information to your smart devices??**
1 - Less desirable, 5 - Very Important
Mark only one oval per row.

	1	2	3	4	5
Monitoring Gear Change Pattern					
Keeping track of maintenance and repair performed					
Monitor usage of brakes during ride					
Record distance covered daily					
Measure the heart rate during riding					

34. **Any comment.**

Stop filling out this form.

Survey on Bike Sharing System

This section is to study the possibility of using a smart bike instead of the traditional bike in Bike Sharing System. A smart bike can be defined as one that share their location to a main server using wireless technology and guide the user through a comfortable ride.

35. **On a scale of 1 to 5, do you think it is a good idea to establish communication between a bike and your smart devices?**
By communication we mean that the bike exchange information such as location, gear shift, speed and seat position for instance. And the smart devices help the bike identify its user.
Mark only one oval.

	1	2	3	4	5	
Very Bad						Excellent

36. **Please state why you choose the rating or add any comment.**

37. **On a scale of 1 to 5 how would a smart bike be a good solution to address problem like vandalism and theft?**
Mark only one oval.

	1	2	3	4	5	
Very Bad						Excellent

38. **Please state why you choose the rating or add any comment.**

39. On a scale of 1 to 5, what is your opinion on having the possibility to localise your bike through your smart devices?
Mark only one oval.

	1	2	3	4	5	
Very Bad	◯	◯	◯	◯	◯	Excellent

40. Please state why you choose the rating or add any comment.

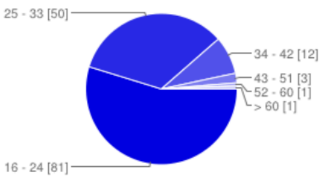
41. On a scale of 1 to 5, what is your opinion on having a bike which have the following features and send these information to your smart devices??
1 - Less desirable, 5 - Very Important
Mark only one oval per row.

	1	2	3	4	5
Monitoring Gear Change Pattern	◯	◯	◯	◯	◯
Keeping track of maintenance and repair performed	◯	◯	◯	◯	◯
Monitor usage of brakes during ride	◯	◯	◯	◯	◯
Record distance covered daily	◯	◯	◯	◯	◯
Measure the heart rate during riding	◯	◯	◯	◯	◯

42. Any comment.

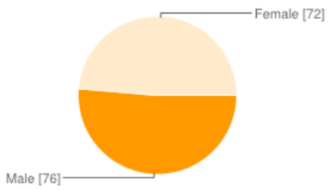
Responses

Age



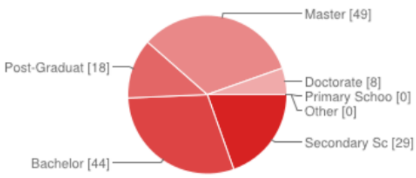
16 - 24	81	54.7%
25 - 33	50	33.8%
34 - 42	12	8.1%
43 - 51	3	2%
52 - 60	1	0.7%
> 60	1	0.7%

Gender



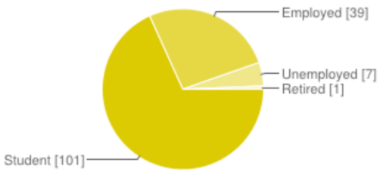
Male	76	51.4%
Female	72	48.6%

What is your educational level?



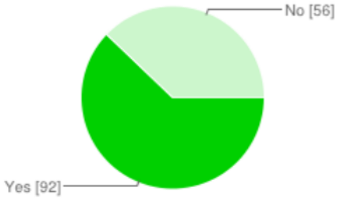
Primary School	0	0%
Secondary School	29	19.6%
Bachelor	44	29.7%
Post-Graduation	18	12.2%
Master	49	33.1%
Doctorate	8	5.4%
Other	0	0%

What is your occupation?



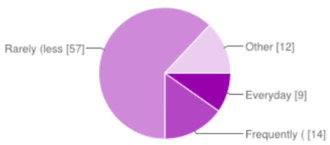
Student	101	68.2%
Employed	39	26.4%
Unemployed	7	4.7%
Retired	1	0.7%

Do you have your own bike?



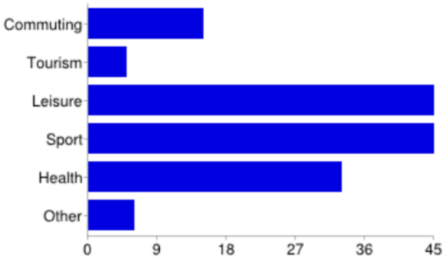
Yes	92	62.2%
No	56	37.8%

What is the frequency of use of your bike?



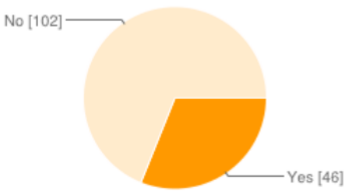
Everyday	9	6.1%
Frequently (more than 3 times a week)	14	9.5%
Rarely (less than 3 times a week)	57	38.5%
Other	12	8.1%

What is the reason for using the bike?



Commuting	15	10.1%
Tourism	5	3.4%
Leisure	45	30.4%
Sport	45	30.4%
Health	33	22.3%
Other	6	4.1%

Have you heard of Bike Sharing System?

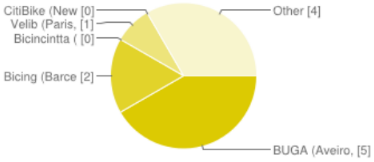


Yes	46	31.1%
No	102	68.9%

Have you use a bike sharing system?

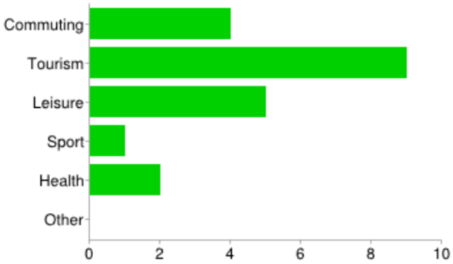
Yes	12	8.1%
No	136	91.9%

Which of the following bike sharing system have you used?



BUGA (Aveiro, Portugal)	5	3.4%
Bicing (Barcelona, Spain)	2	1.4%
Bicincitta (Italy)	0	0%
Velib (Paris, France)	1	0.7%
CitiBike (New York, USA)	0	0%
Other	4	2.7%

What is the reason for using the bike sharing system?

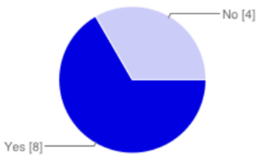


Commuting	4	2.7%
Tourism	9	6.1%
Leisure	5	3.4%
Sport	1	0.7%
Health	2	1.4%
Other	0	0%

What is the frequency of usage of the bike sharing system?

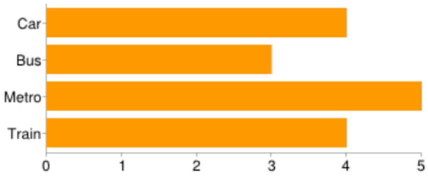
< 10 times a month	11	7.4%
Between 10 to 20 times a month	0	0%
> 20 times a month	1	0.7%

Do you use other mean of transport along with the bike?



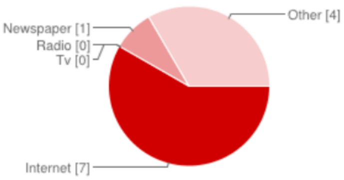
Yes	8	5.4%
No	4	2.7%

If yes, which one?



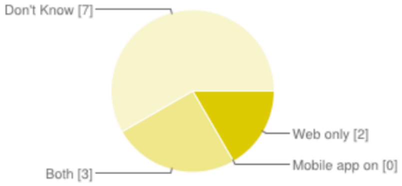
Car	4	2.7%
Bus	3	2%
Metro	5	3.4%
Train	4	2.7%

How you became aware of such a system?



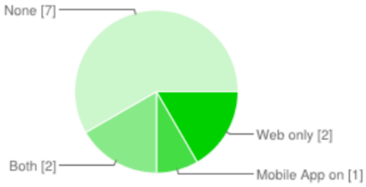
Internet	7	4.7%
Radio	0	0%
Tv	0	0%
Newspaper	1	0.7%
Other	4	2.7%

Is the service information available on the web or a mobile app?



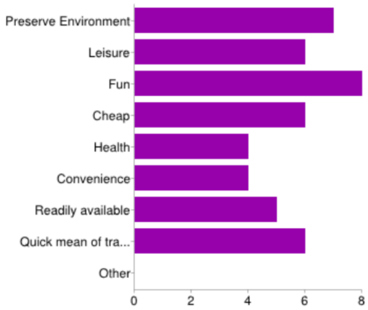
Web only	2	1.4%
Mobile app only	0	0%
Both	3	2%
Don't Know	7	4.7%

Have you use the app or the web?



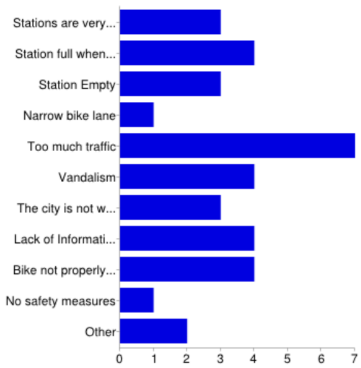
Web only	2	1.4%
Mobile App only	1	0.7%
Both	2	1.4%
None	7	4.7%

What are or were the reasons for you to use this type of service?



Preserve Environment	7	4.7%
Leisure	6	4.1%
Fun	8	5.4%
Cheap	6	4.1%
Health	4	2.7%
Convenience	4	2.7%
Readily available	5	3.4%
Quick mean of transport	6	4.1%
Other	0	0%

What are the main problems you encountered during the usage of the system?

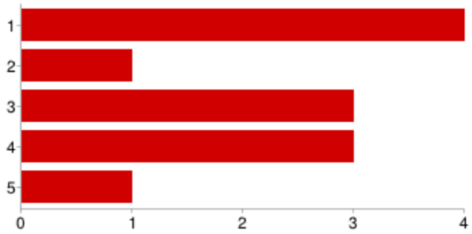


Stations are very far from each other	3	2%
Station full when returning bike	4	2.7%
Station Empty	3	2%
Narrow bike lane	1	0.7%
Too much traffic	7	4.7%
Vandalism	4	2.7%
The city is not well adapted for bike sharing	3	2%
Lack of Information on the service	4	2.7%
Bike not properly maintained	4	2.7%
No safety measures	1	0.7%
Other	2	1.4%

What are the good aspects of the service?

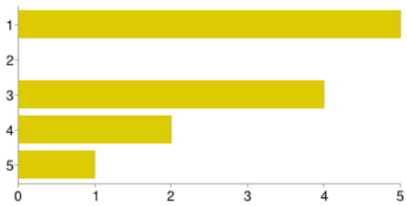
Price	8	5.4%
Ease of Use	6	4.1%
Accessibility	6	4.1%
No worry about maintenance of bike	5	3.4%
No worry about theft	5	3.4%
Readily available	6	4.1%
Efficient mean of transport	4	2.7%
Other	0	0%

Web Interface [Rate the following components of the service on a scale 0 to 5]



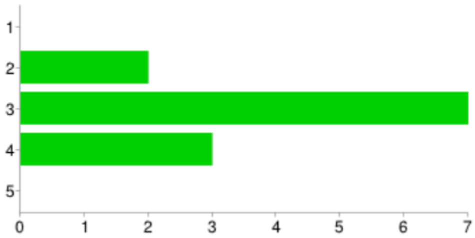
1	**4**	2.7%
2	**1**	0.7%
3	**3**	2%
4	**3**	2%
5	**1**	0.7%

Mobile App [Rate the following components of the service on a scale 0 to 5]



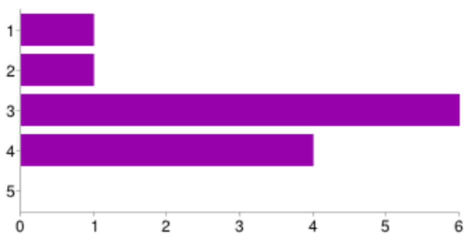
1	**5**	3.4%
2	**0**	0%
3	**4**	2.7%
4	**2**	1.4%
5	**1**	0.7%

Station [Rate the following components of the service on a scale 0 to 5]



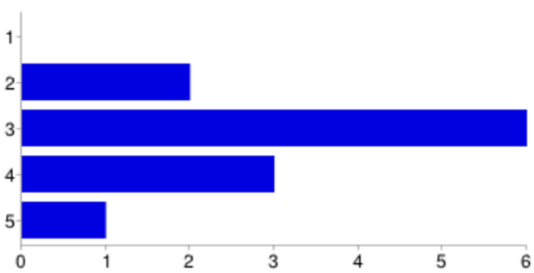
1	**0**	0%
2	**2**	1.4%
3	**7**	4.7%
4	**3**	2%
5	**0**	0%

Information Kiosk [Rate the following components of the service on a scale 0 to 5]



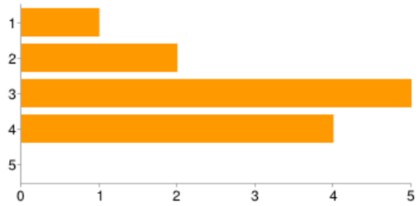
1	**1**	0.7%
2	**1**	0.7%
3	**6**	4.1%
4	**4**	2.7%
5	**0**	0%

Bike [Rate the following components of the service on a scale 0 to 5]



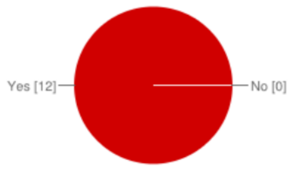
1	**0**	0%
2	**2**	1.4%
3	**6**	4.1%
4	**3**	2%
5	**1**	0.7%

Customer Support Service [Rate the following components of the service on a scale 0 to 5]



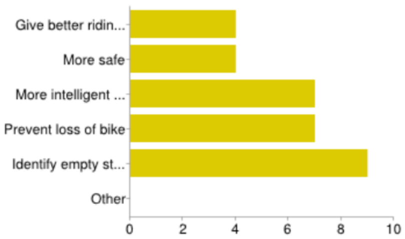
1	**1**	0.7%
2	**2**	1.4%
3	**5**	3.4%
4	**4**	2.7%
5	**0**	0%

Would you use the service again?



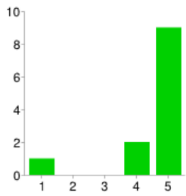
Yes	**12**	8.1%
No	**0**	0%

How is a smart bike sharing system a better alternative to the current system?



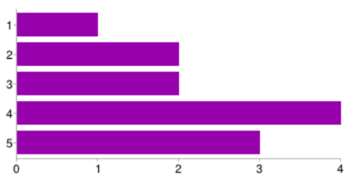
Give better riding experience	**4**	2.7%
More safe	**4**	2.7%
More intelligent in tracking traffic pattern	**7**	4.7%
Prevent loss of bike	**7**	4.7%
Identify empty station autonomously	**9**	6.1%
Other	**0**	0%

On a scale of 1 to 5, do you think it is a good idea to establish communication between your bike and your smart devices?



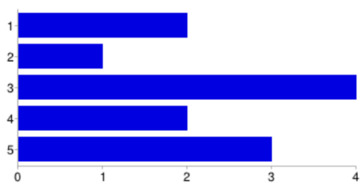
1	**1**	0.7%
2	**0**	0%
3	**0**	0%
4	**2**	1.4%
5	**9**	6.1%

Theft [On a scale of 1 to 5 how would a smart bike be a good solution to address the following issues?]



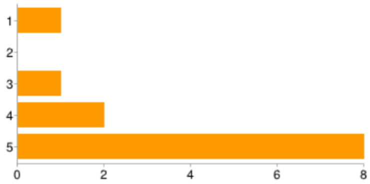
1	**1**	0.7%
2	**2**	1.4%
3	**2**	1.4%
4	**4**	2.7%
5	**3**	2%

Vandalism [On a scale of 1 to 5 how would a smart bike be a good solution to address the following issues?]



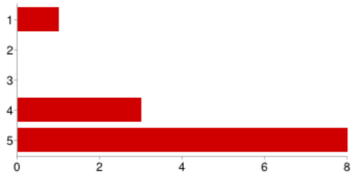
1	**2**	1.4%
2	**1**	0.7%
3	**4**	2.7%
4	**2**	1.4%
5	**3**	2%

Empty Station [On a scale of 1 to 5 how would a smart bike be a good solution to address the following issues?]



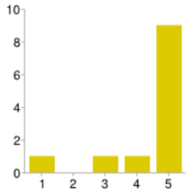
1	**1**	0.7%
2	**0**	0%
3	**1**	0.7%
4	**2**	1.4%
5	**8**	5.4%

Full Station [On a scale of 1 to 5 how would a smart bike be a good solution to address the following issues?]



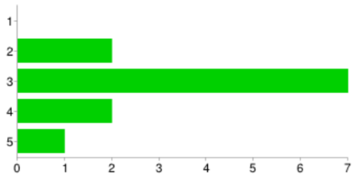
1	**1**	0.7%
2	**0**	0%
3	**0**	0%
4	**3**	2%
5	**8**	5.4%

On a scale of 1 to 5, what is your opinion on having the possibility to localise your bike through your smart devices?



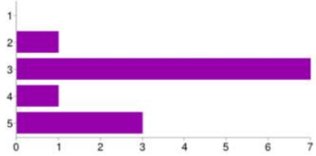
1	**1**	0.7%
2	**0**	0%
3	**1**	0.7%
4	**1**	0.7%
5	**9**	6.1%

Monitoring Gear Change Pattern [On a scale of 1 to 5, what is your opinion on having a bike which have the following features and send these information to your smart devices??]



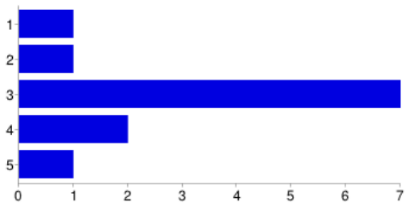
1	**0**	0%
2	**2**	1.4%
3	**7**	4.7%
4	**2**	1.4%
5	**1**	0.7%

Keeping track of maintenance and repair performed [On a scale of 1 to 5, what is your opinion on having a bike which have the following features and send these information to your smart devices??]



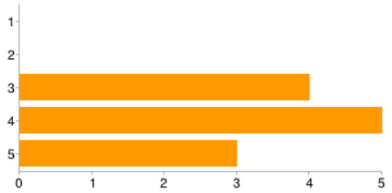
1	**0**	0%
2	**1**	0.7%
3	**7**	4.7%
4	**1**	0.7%
5	**3**	2%

Monitor usage of brakes during ride [On a scale of 1 to 5, what is your opinion on having a bike which have the following features and send these information to your smart devices??]



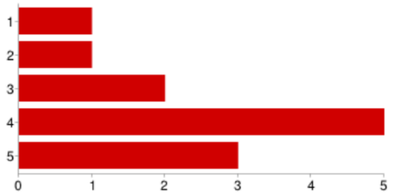
1	**1**	0.7%
2	**1**	0.7%
3	**7**	4.7%
4	**2**	1.4%
5	**1**	0.7%

Record distance covered daily [On a scale of 1 to 5, what is your opinion on having a bike which have the following features and send these information to your smart devices??]



1	**0**	0%
2	**0**	0%
3	**4**	2.7%
4	**5**	3.4%
5	**3**	2%

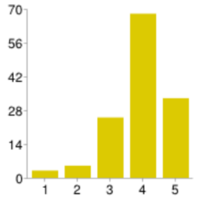
Measure the heart rate during riding [On a scale of 1 to 5, what is your opinion on having a bike which have the following features and send these information to your smart devices??]



1	**1**	0.7%
2	**1**	0.7%
3	**2**	1.4%
4	**5**	3.4%
5	**3**	2%

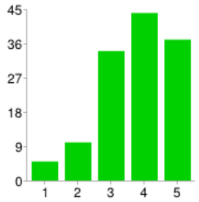
Non Users

On a scale of 1 to 5, do you think it is a good idea to establish communication between a bike and your smart devices?



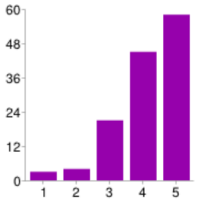
1	**3**	2%
2	**5**	3.4%
3	**25**	16.9%
4	**68**	45.9%
5	**33**	22.3%

On a scale of 1 to 5 how would a smart bike be a good solution to address problem like vandalism and theft?



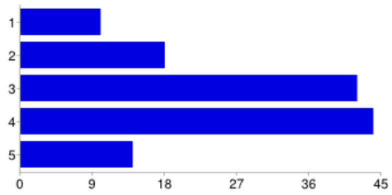
1	**5**	3.4%
2	**10**	6.8%
3	**34**	23%
4	**44**	29.7%
5	**37**	25%

On a scale of 1 to 5, what is your opinion on having the possibility to localise your bike through your smart devices?



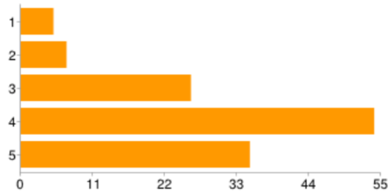
1	**3**	2%
2	**4**	2.7%
3	**21**	14.2%
4	**45**	30.4%
5	**58**	39.2%

Monitoring Gear Change Pattern [On a scale of 1 to 5, what is your opinion on having a bike which have the following features and send these information to your smart devices??]



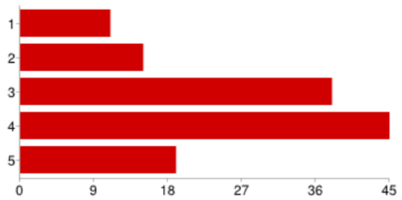
1	**10**	6.8%
2	**18**	12.2%
3	**42**	28.4%
4	**44**	29.7%
5	**14**	9.5%

Keeping track of maintenance and repair performed [On a scale of 1 to 5, what is your opinion on having a bike which have the following features and send these information to your smart devices??]



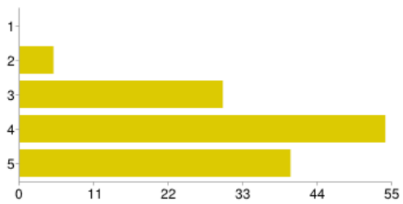
1	**5**	3.4%
2	**7**	4.7%
3	**26**	17.6%
4	**54**	36.5%
5	**35**	23.6%

Monitor usage of brakes during ride [On a scale of 1 to 5, what is your opinion on having a bike which have the following features and send these information to your smart devices??]



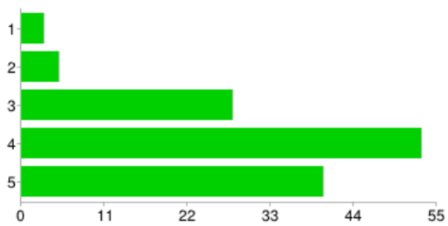
1	**11**	7.4%
2	**15**	10.1%
3	**38**	25.7%
4	**45**	30.4%
5	**19**	12.8%

Record distance covered daily [On a scale of 1 to 5, what is your opinion on having a bike which have the following features and send these information to your smart devices??]



1	**0**	0%
2	**5**	3.4%
3	**30**	20.3%
4	**54**	36.5%
5	**40**	27%

Measure the heart rate during riding [On a scale of 1 to 5, what is your opinion on having a bike which have the following features and send these information to your smart devices??]



1	**3**	2%
2	**5**	3.4%
3	**28**	18.9%
4	**53**	35.8%
5	**40**	27%

Appendix D Service Experience Blueprint

Registration through web portal

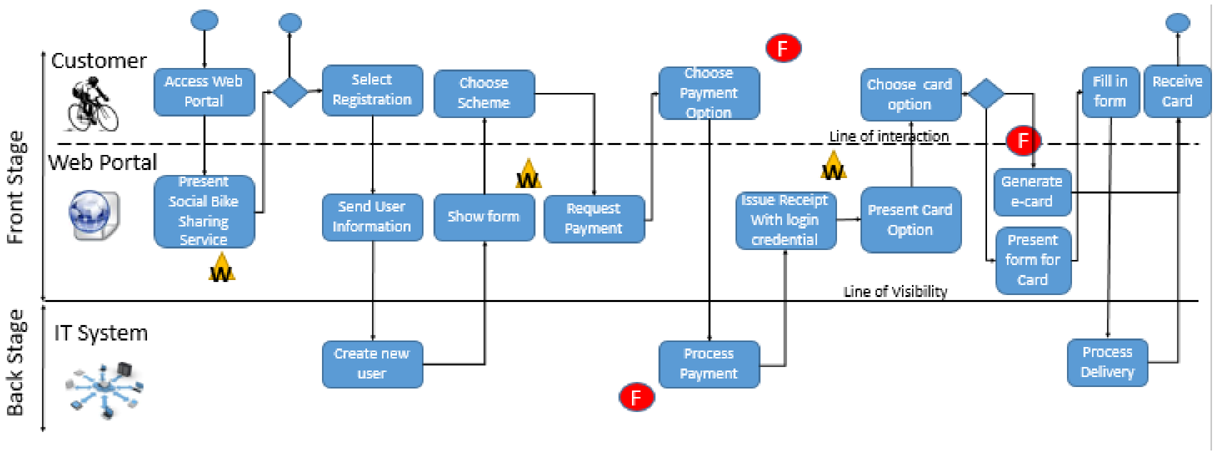


Figure 26 SEB registration on web portal

Figure 26 describes the registration process through the web portal. The user browses the website and chooses to register to the system by providing his information and choosing the scheme he desires. He effectuates the payment and receives a receipt with his login credential. After that, he can choose the type of cards to use either an e-card or a normal one. For the normal one, he needs to fill in a form for the pick-up point. Once the card is received, the user can start to use the service. The failures that can arise is during processing the payment as there will be some connection with the bank server to recognise the payment. Another failure can be during the generation of the e-card due to the system being slow in processing. The waiting will be mainly due to the system taking time to process information.

Registration on mobile app

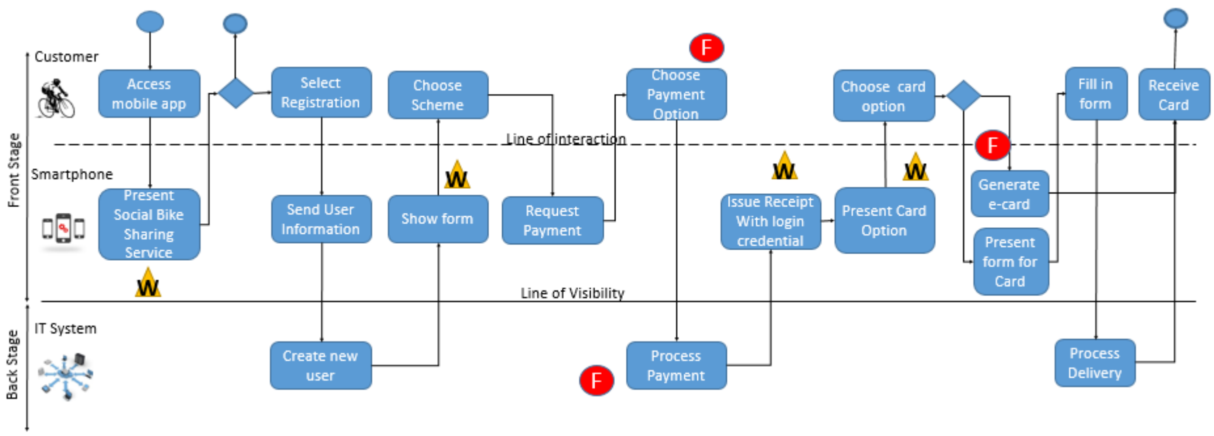


Figure 27 SEB registration on mobile app

Figure 27 describes the registration process through the mobile app. The user have the app already downloaded and chooses to register to the system by providing his information and choosing the scheme he desires. He effectuates the payment and receives a receipt with his login credential. After that, he can choose the type of cards to use, either an e-card or a normal one. For the normal one, he need to fill in a form for the pick-up point. Once the card is received, the user can start to use the service. The failures that can arise is during processing the payment as there will be some connection with the bank server to recognise the payment. Another failure can be during the generation of the e-card due to the system being slow in processing. The waiting is mainly due to the system taking time to process information.

Registration at Store

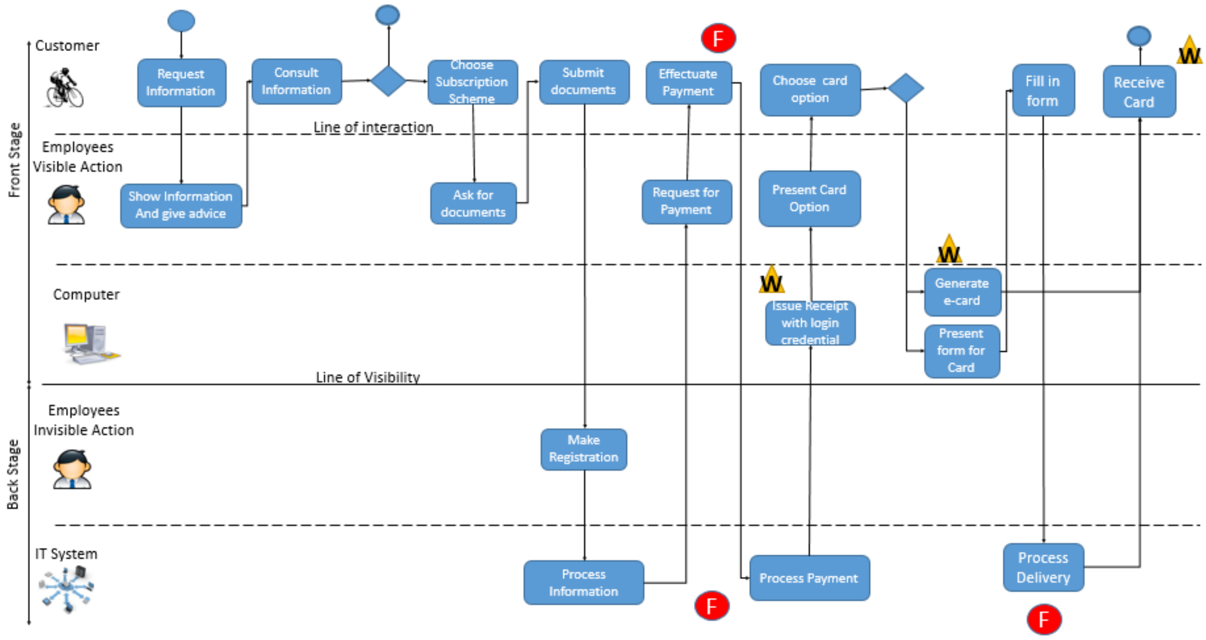


Figure 28 SEB Registration at Store

Figure 28 describes the registration process at the store. The user go to the store and is briefed by the employee. He chooses to register to the system by providing his information and choosing the scheme he desires. He effectuates the payment and receives a receipt with his login credential. After that, he can choose the type of cards to use either an e-card or a normal one. At the store, he can immediately receive the card. Once the card is received, the user can start to use the service. If he decide to have an e-cards, he receive it by email. The failures that can arise is during processing the payment as there will be connection with the bank server while using the card machine. Another failure can be during the generation of the e-card due to the system being slow in processing. The waiting is mainly due to the system taking time to process information.

Appendix E Business Model Canvas

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
• Mobi.Me • Municipality • Businesses: shopping mall, cinemas, electronic store • Operators • Advertising companies • Hotels • Tourists operators	• Subscription Management • Fleet Management • Maintenance of bike and station • Customer Support Service • Distribution Management • Data Management • Social Riding Network Management	• Socially connected intelligent bike embedded with the latest technology that have the aim to capture data about riding behaviour, social behaviour and enhance the riding experience of the user. • This new concept will make use of the Social Internet of Things paradigm providing the maximum security to users and giving them the freedom to set the control of the 'smart bike' to behave according to their wish.	• Co-Creation • Communities	• Student: Primary, Secondary and Tertiary students that uses bike as a mean to go to school and university. • Workers: People aged more than 18 yrs old and uses the bike as a quick mean of transport to go to work. Avoid traffic and be on time. • Residents: People aged more than 14 yrs old living in a particular region whereby the bikesharing services is offered. • Tourists: In search of fun and exploration
	Key Resources • People: maintenance personnel, IT engineer, Store attendant • Store • Bike • Spare Parts		**Channels** • Social Media • Advertisement • Website • Mobile App • Partnership • Word of Mouth • Physical Store	

Cost Structure	Revenue Streams
• Maintenance Cost • Human Resource • IT resource • Marketing • Infrastructure • Bikes • Power to charge the bike	• Service Usage • Advertisement • Traceability of Purchase

Figure 29 Business Model Canvas SSB

Appendix F Service Goals

The super goal of the service is: The system shall provide a socially connected bike sharing service. To support the super goal, the following sub-goals are required:

G1: The system shall improve businesses

G1.1: The system shall improve day to day operation.

G1.2: The system shall allow the location of bike.

G1.3: The system shall facilitate urban planning.

G1.4: The system shall generate heat maps of the most frequent visit places.

G1.5: The system shall reduce theft.

G1.6: The system shall reduce vandalism.

G2: The system shall improve the user experience

G2.1: The system shall have an updated information to users about bike availability, station status.

G2.2: The system shall provide proper corrective measure in case of mistakes.

G2.3: The system shall process new registration fast.

G2.4: The system shall provide information on points of interest to visit and also provide a bike buddy.

G2.5: The system shall provide safe and well maintained bike.

G2.6: The system shall provide bikes with close proximity.

G2.7: The system shall provide a system which allow the user to choose to be localised or not.

G2.8: The system shall allow and provide discovery of new places.

G2.9: The system shall provide security that is controlled through a remote place and users shall not be aware of which component is sending information about whereabouts.

G2.10: The system shall treat all complaints as quick as possible and provide feedbacks.

G3: The system shall integrate private bike

G3.1: The system shall provide connection to the private bike in the ecosystem.

G3.2: The system shall allow private users to have the same functionalities as other users.

G4: The system shall create information

G4.1: The system shall capture data about riding patterns of the users.

G4.2 The system shall capture data about the behavior of users.

G4.3: The system shall capture data about the environment.

G4.3: The system shall give the user information that they want.

G4.4: The system shall process all the information gathered

G4.5: The system shall provide traceability of information.

The KAOS diagrams for the super goals and sub goals are given in figure 29, 30, 31, 32 and 33.

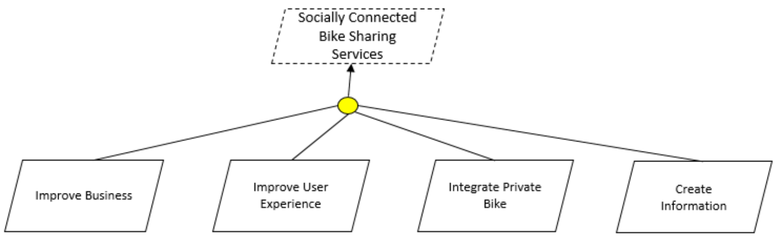


Figure 30 Super Goal: Social Connected Bike Sharing Services

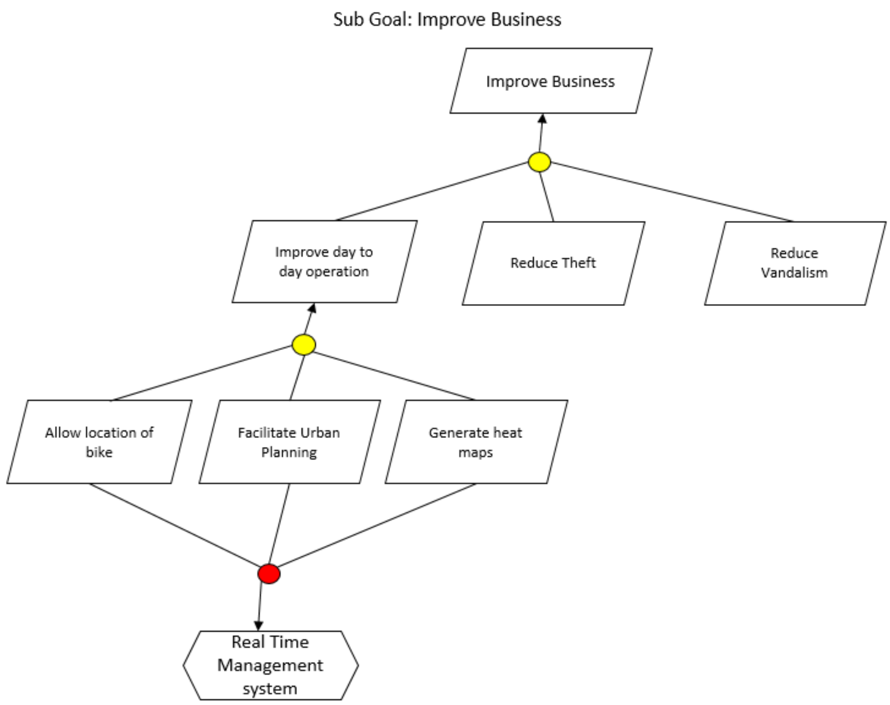


Figure 31 Sub Goal Improve Business

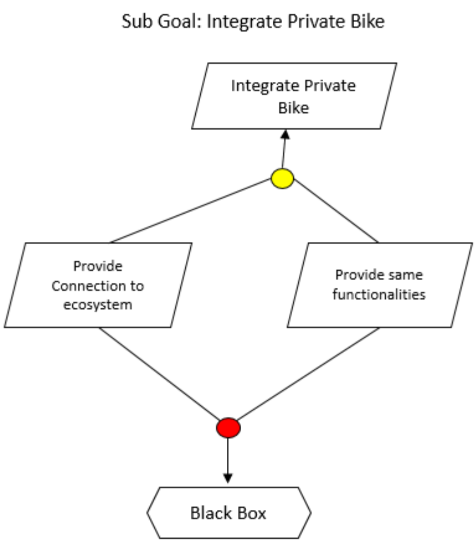


Figure 32 Sub Goal Integrate Private Bike

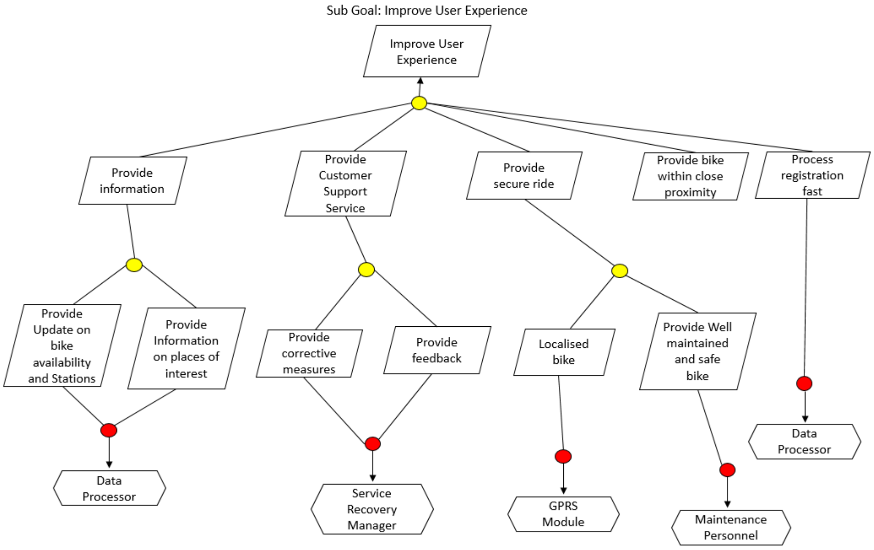


Figure 33 Improve User Experience

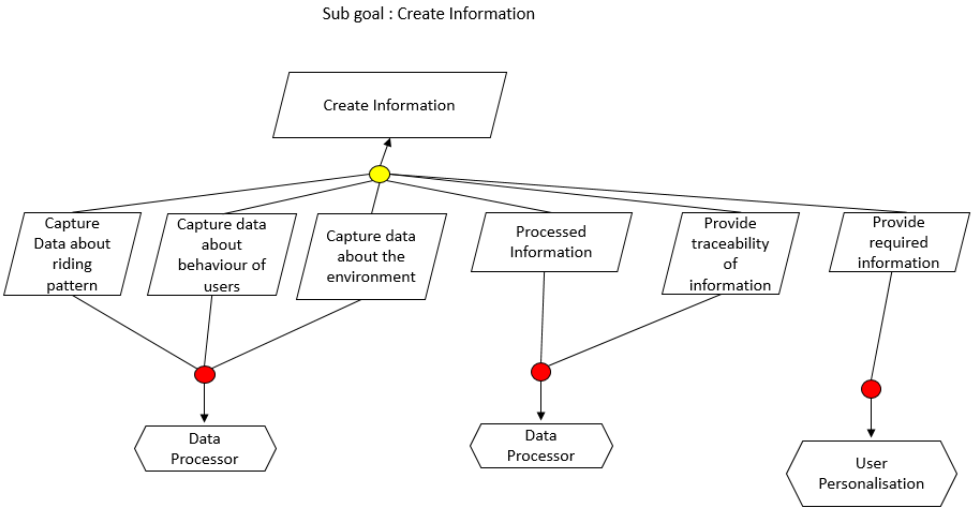


Figure 34 Sub Goal Create Information

Appendix G Use Cases

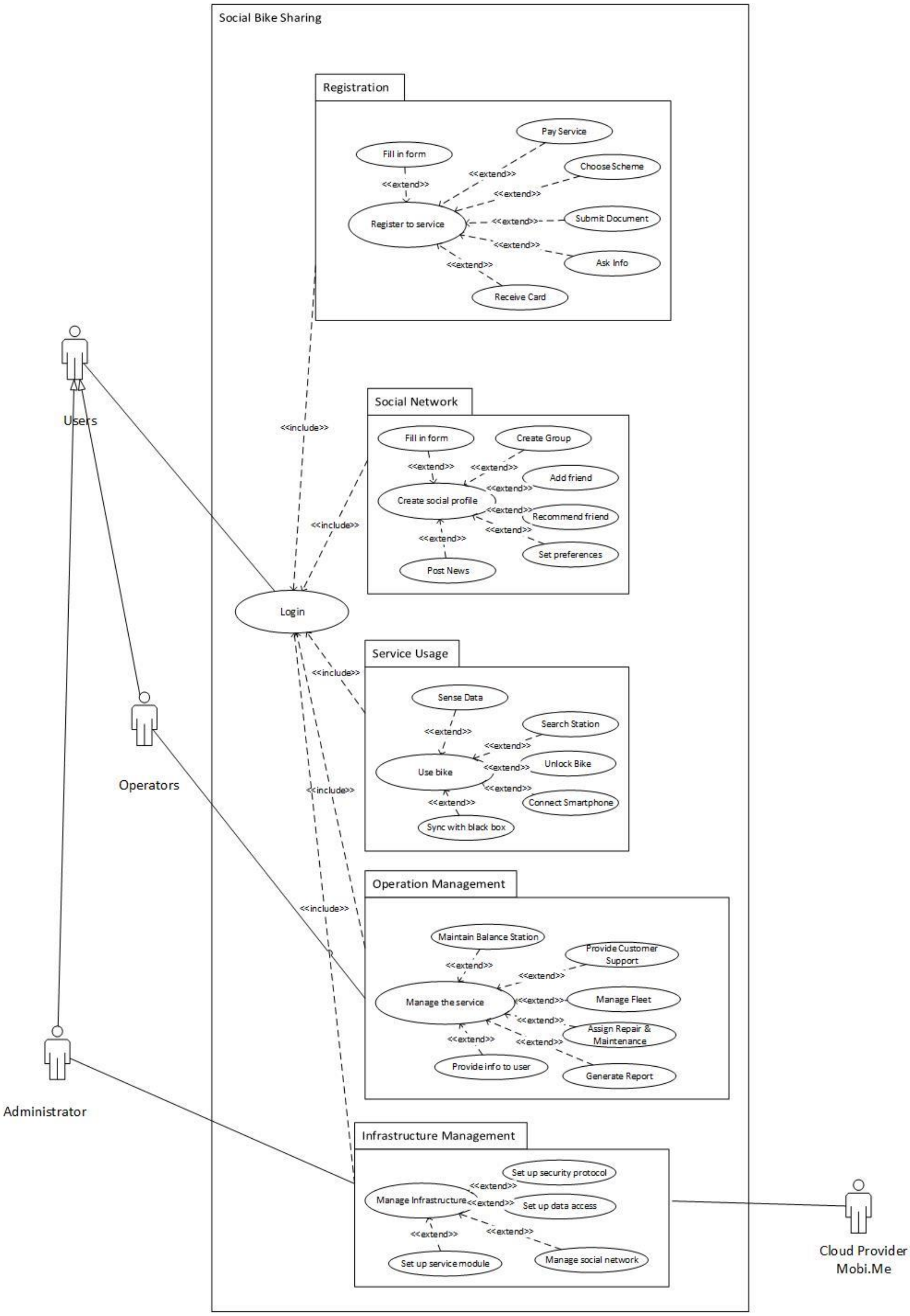


Figure 35 Use Case Diagram for SSB

Table 10 List of Use Cases

No	Name	ID
1	Register to service	UC-01
2	Fill in form	UC-02
3	Pay Service	UC-03
4	Choose Scheme	UC-04
5	Submit Document	UC-05
6	Ask info	UC-06
7	Receive Card	UC-07
8	Create Social Profile	UC-08
9	Fill in form	UC-09
10	Create Group	UC-10
11	Add friend	UC-11
12	Recommend friend	UC-12
13	Set preferences	UC-13
14	Post News	UC-14
15	Use Bike	UC-15
16	Sense Data	UC-16
17	Search Station	UC-17
18	Unlock Bike	UC-18
19	Connect Smartphone	UC-19
20	Sync with black box	UC-20
21	Manage Service	UC-21
22	Maintain Balance Station	UC-22
23	Provide Customer Support	UC-23
24	Manage Fleet	UC-24
25	Assign Repair & Maintenance	UC-25
26	Generate Report	UC-26
27	Provide info to user	UC-27
28	Manage Infrastructure	UC-28
29	Set up security protocol	UC-29
30	Set up data access	UC-30
31	Set up service module	UC-31

No	Name	ID
32	Manage Social Network	UC-32

Appendix H Functional Requirement

Table 11 Identification of functional requirement

SRS ID	Description	Source	Priority
FR-01	The system shall store data in a cloud	Project Supervisor	E
FR-02	The system have an interface to 3rd Parties	Documentation	C
FR-03	The system shall allow users to add recommendation	Requirement Engineer	C
FR-04	The system shall allow the users to register through 3 means: at the store, on the web portal or using the mobile app	Requirement Engineer	E
FR-05	The system shall provide different scheme to users	Requirement Engineer	E
FR-06	The system shall allow easy uploading of documents	Requirement Engineer	C
FR-07	The system shall provide up-to-date information to users	Requirement Engineer	E
FR-08	The system shall allow users to create a social profile on a social riding network	Requirement Engineer	E
FR-09	The system shall allow the localization of the bike	Requirement Engineer	E
FR-10	The system shall provide well maintained bike	Requirement Engineer	E
FR-11	The system shall provide good station facilities with minimum downtime	Requirement Engineer	E
FR-12	The system shall allow connection to the internet	Requirement Engineer	E
FR-13	The system shall provide real time-management	Documentation	C
FR-14	The system shall capture data according to users wish	Requirement Engineer	E
FR-15	The system shall allow the posting of news on the SRN	Requirement Engineer	O
FR-16	The system shall allow the setting of preferences according to the users wish	Requirement Engineer	E

SRS ID	Description	Source	Priority
FR-17	The system shall allow the user to send friend request to other members	Requirement Engineer	O
FR-18	The system shall provide the facility of having physical card or e-card	Requirement Engineer	C
FR-19	The system shall allow the connection of smartphone to black box of the bike	Requirement Engineer	C
FR-20	The system shall allow monitor the service usage of each customer	Requirement Engineer	C
FR-21	The system shall maintain balance station, with enough bike and parking space	Project Supervisor	E
FR-22	The system shall provide quick customer support	Requirement Engineer	E
FR-23	The system shall properly manage the fleet of bike	Requirement Engineer	E
FR-24	The system shall assign promptly maintenance and repair to artifact in need	Requirement Engineer	E
FR-25	The system shall generate maintenance report, usability report about bike and station	Project Supervisor	C
FR-26	The system shall ensure security protocols are respected	Requirement Engineer	E
FR-27	The system shall preserve data according to some standard	Requirement Engineer	E
FR-28	The system shall allow different mode of payment	Requirement Engineer	C
FR-29	The system shall process the data collected into meaningful info to operators and partners	Requirement Engineer	E
FR-30	The system shall provide a virtual or real bike buddy	Requirement Engineer	C
FR-31	The system shall collect feedback from users to improve services	Requirement Engineer	C
FR-32	The system shall provide a unique code to each bike for identification purposes	Documentation	E
FR-33	The system shall allow users to define what information to share to the community	Documentation	E
FR-34	The system shall allow the user to choose the type of relationship he wants to display, public or private	Documentation	E
FR-35	The system shall create a profile for each bike	Documentation	E
FR-36	The system shall autonomously seek relationships as set by the user	Documentation	C

SRS ID	Description	Source	Priority
FR-37	The system shall allow the bike to communicate with each other and exchange information	Documentation	E
FR-38	The system shall synthesize the different data received into the same language and protocol	Documentation	E
FR-39	The system shall provide meaningful information to users, operators and partners	Requirement Engineer	E

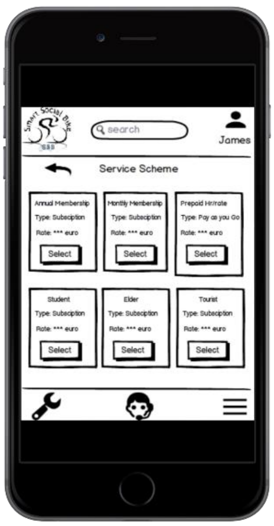
Appendix I Quality Requirement

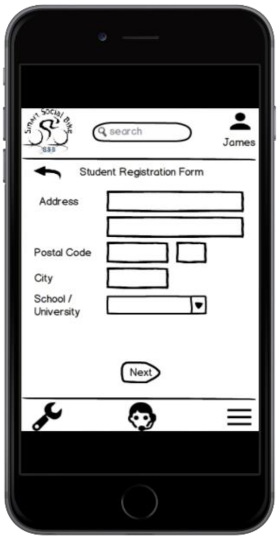
Table 12 Identification of Quality Requirement

SRS ID	Description	Source	Priority
QR-01	The system homepage for the unregistered user shall include a login form including username/password and login and register options	Requirement Engineer	E
QR-02	The system shall validate new password which is at least eight characters long and contains alphanumeric characters when users change the password	Requirement Engineer	E
QR-03	The user passwords stored in the system shall be protected against password theft	Requirement Engineer	E
QR-04	The system shall protect data from theft	Requirement Engineer	E
QR-05	The mobile app shall be built to support capacity, RAM, CPU of smartphone	Requirement Engineer	C
QR-06	The system shall be available for users 95% of the time and 5% for maintenance	Requirement Engineer	C
QR-07	The system shall be built by modules so that changes or improvements are made in one module without interfering with the other modules.	Requirement Engineer	C
QR-08	The system shall allow new modules to be added if case be.	Requirement Engineer	C
QR-09	The system shall include interfaces to other service apis	Requirement Engineer	C
QR-10	The system shall be designed in a way that maintenance in a module doesn't affect functioning of other modules	Requirement Engineer	E
QR-11	The system shall work in different operating system for mobile phone	Requirement Engineer	E

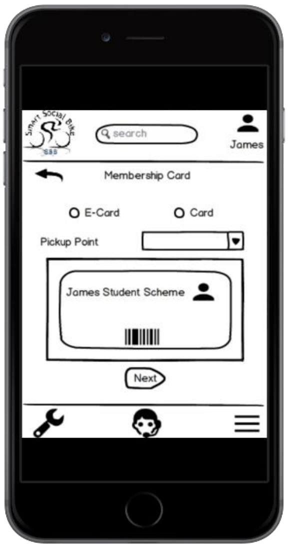
SRS ID	Description	Source	Priority
QR-12	The system shall provide a unique identifier to each bike	Requirement Engineer	E
QR-13	The system shall recognise the user and his preferences each time he uses the service	Requirement Engineer	E
QR-14	Each time the customer uses the service, the system shall update automatically his profile	Requirement Engineer	C
QR-15	The system will harmonize the different data received into a common language	Requirement Engineer	E

Appendix K Mockups




search
James
Student Registration Form
Address
Postal Code
City
School / University
Next


search
James
Stations
Aliados
Sao Bento
Trinidade
Ribeira
Paranhos
Description
Status
Aliados is right in the city of Porto, offering a magnificient view of the Camara Municipal do
Number of Bike 12
Parking Slots 6
Reserve a Bike


search
James
Membership Card
E-Card
Card
Pickup Point
James Student Scheme
Next


search
James
Payment
Billing Country
Payment Type
Card or Account
Expiry Date
CVV/CID
Month
Year
Purchase
VISA

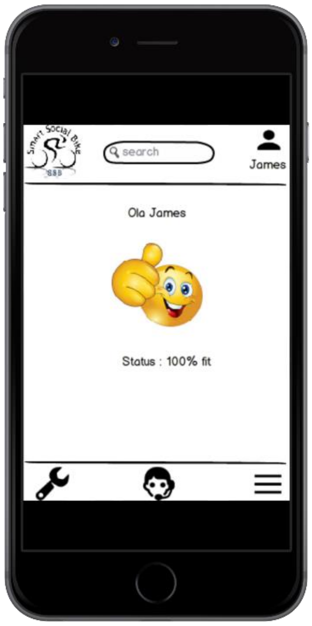

search
James
Social Riding Network
Who can see my post?
Who can connect me?
Receive Promotion from Partners
Yes
No
Which one?
Shopping Mall
Supermarket
Restaurants
Cinemas
Analyse Riding Behavior
travel time
speed monitor
calories burned

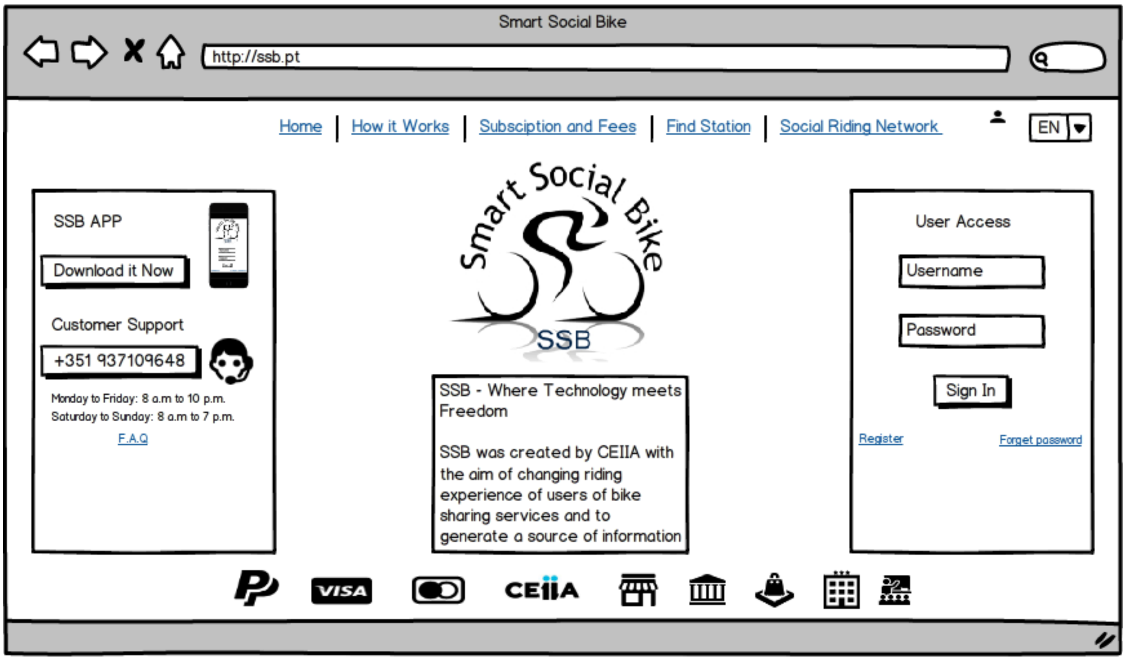

search
James
Ola James
Syn Mode
Please Wait

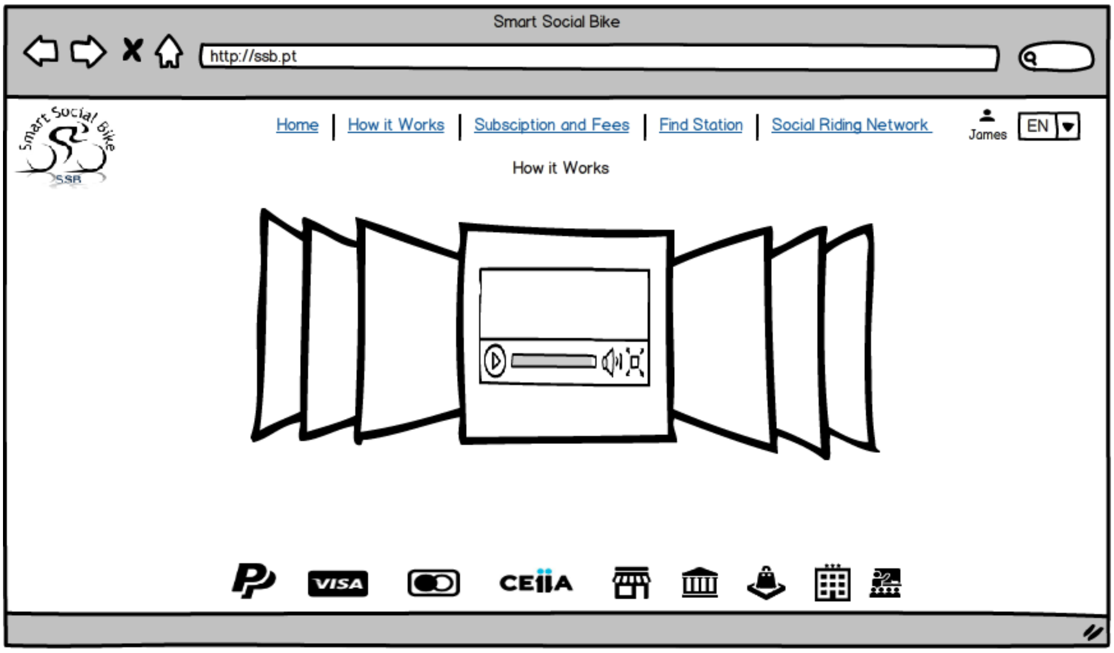

search
James
Usage
Distance Covered: 2 km
Calories Burned: 50
Promo at Supermarket X 50 %
Traffic Slow 100 m infront
Museu do Vinho 50m infront

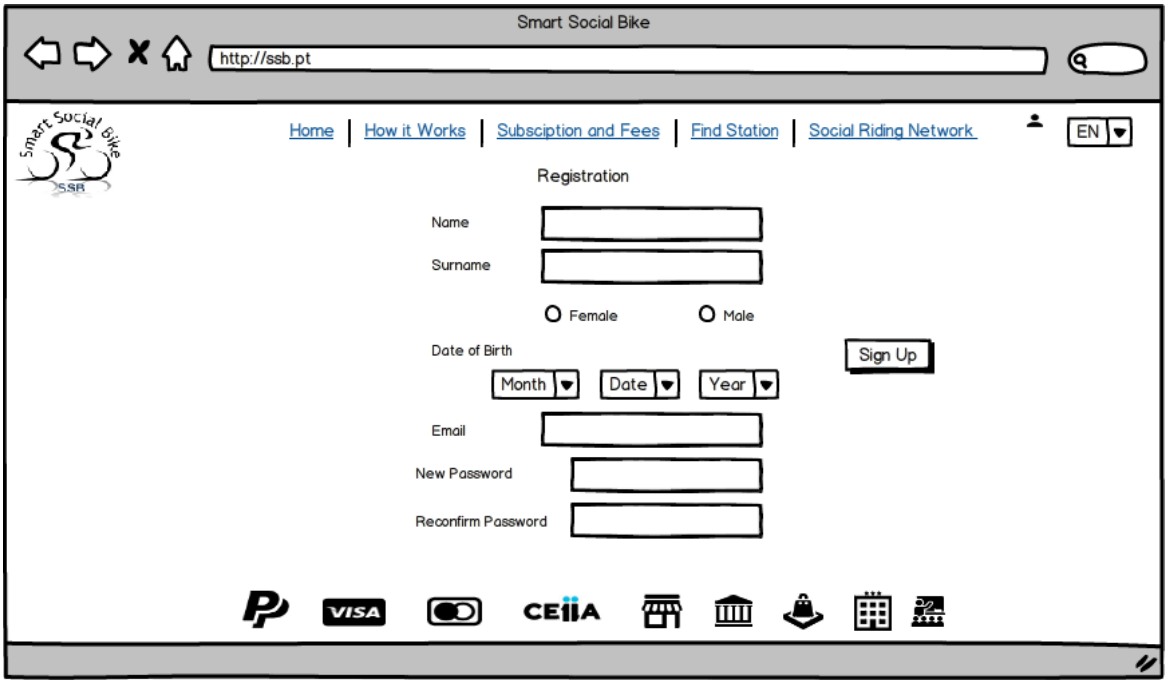

search
James
Social Riding Network
Newsfeed
Paula check in at Leça da Palmeira
John sent a time challenge to Ana
John biked 50km and burned 500 calories

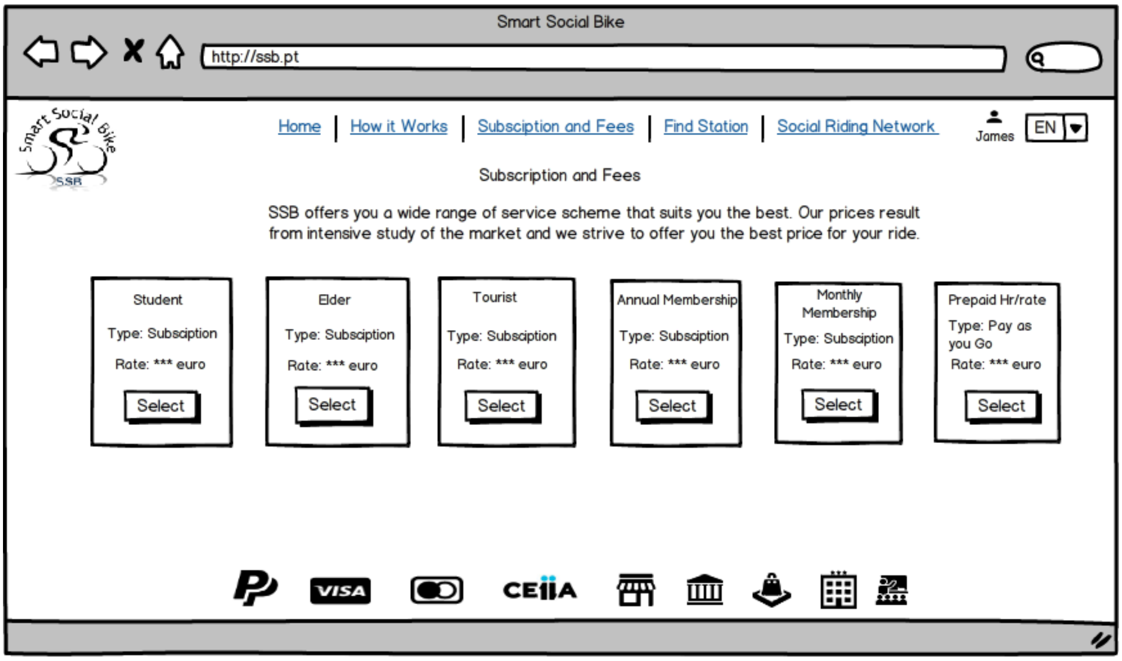

search
James
Social Riding Network
My Profile
Friends > Routes > Activity feed > Statistic
Riding
Distance covered: 60 km
Places Most visited: Matosinhos
Calories Burned: 750
Challenge Accepted: 2
Challenge: 1
Social
Mall most visited: Doce Vitale
Shops with more purchase: Super X
Products most bought: Ovos

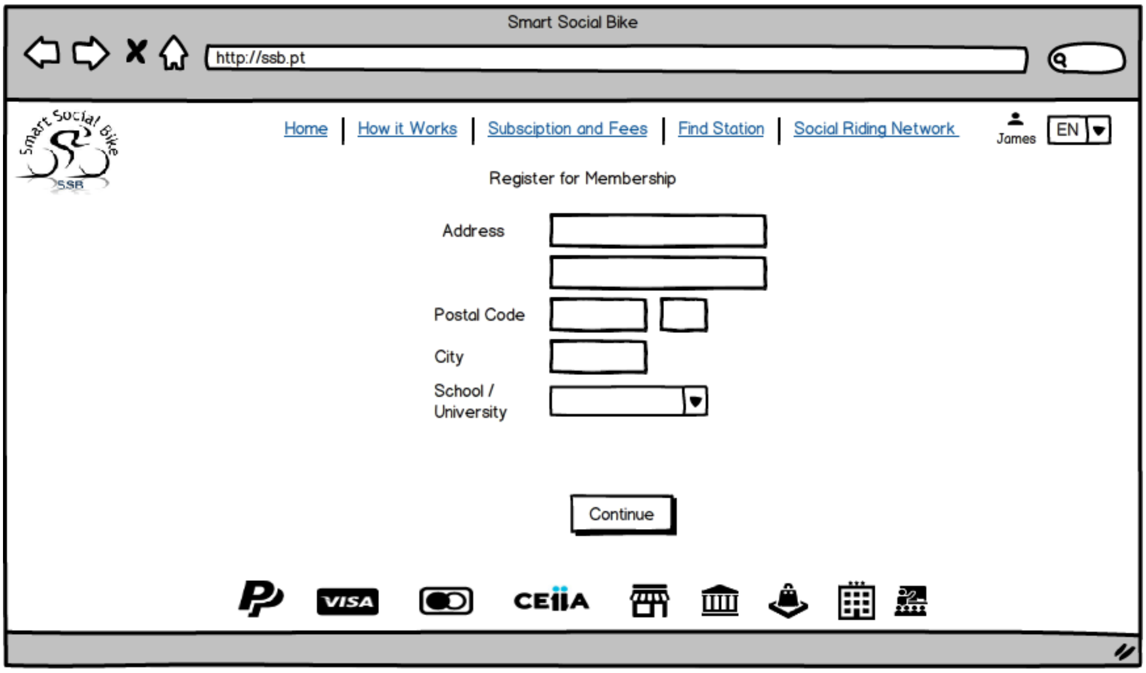

search
James
Ola James
Status : 100% fit

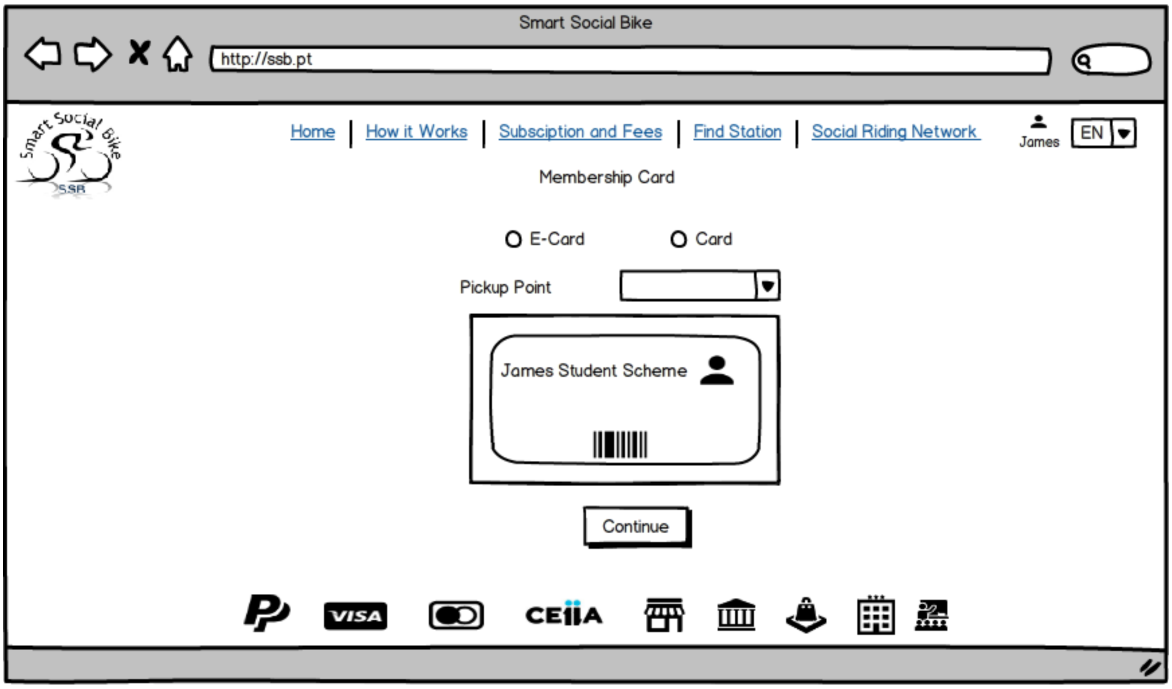

Smart Social Bike
http://ssb.pt
Home | How it Works | Subsciption and Fees | Find Station | Social Riding Network
EN
SSB APP
Download it Now
Customer Support
+351 937109648
Monday to Friday: 8 a.m to 10 p.m.
Saturday to Sunday: 8 a.m to 7 p.m.
F.A.Q
Smart Social Bike
SSB
SSB - Where Technology meets Freedom
SSB was created by CEIIA with the aim of changing riding experience of users of bike sharing services and to generate a source of information
User Access
Username
Password
Sign In
Register
Forget password
VISA
CEiiA

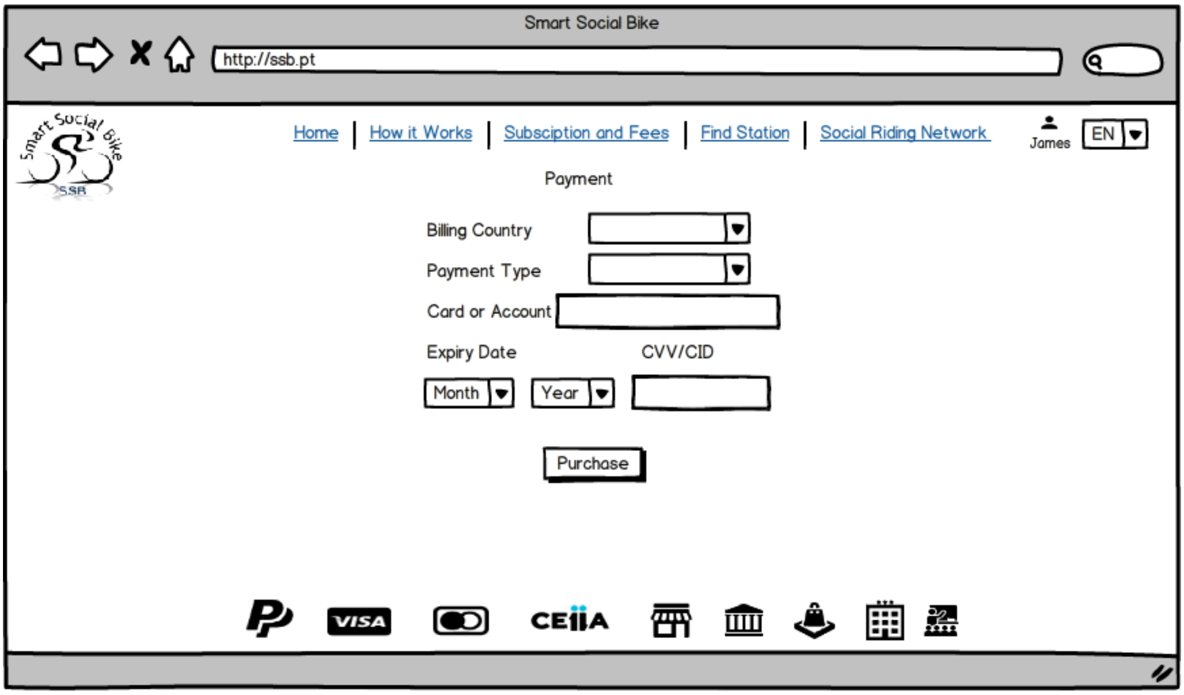

Smart Social Bike
http://ssb.pt
Home | How it Works | Subsciption and Fees | Find Station | Social Riding Network
James
EN
How it Works
VISA
CEiiA

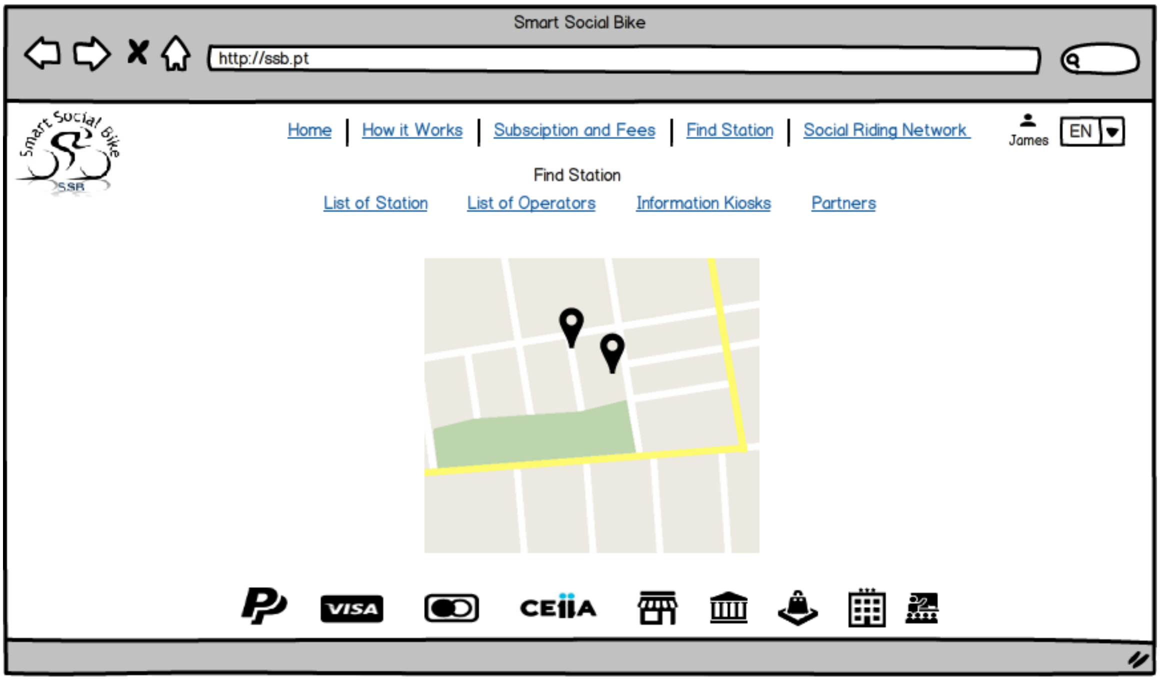

Smart Social Bike
http://ssb.pt
Home | How it Works | Subsciption and Fees | Find Station | Social Riding Network
EN
Registration
Name
Surname
Female
Male
Date of Birth
Month
Date
Year
Sign Up
Email
New Password
Reconfirm Password
VISA
CEIIA

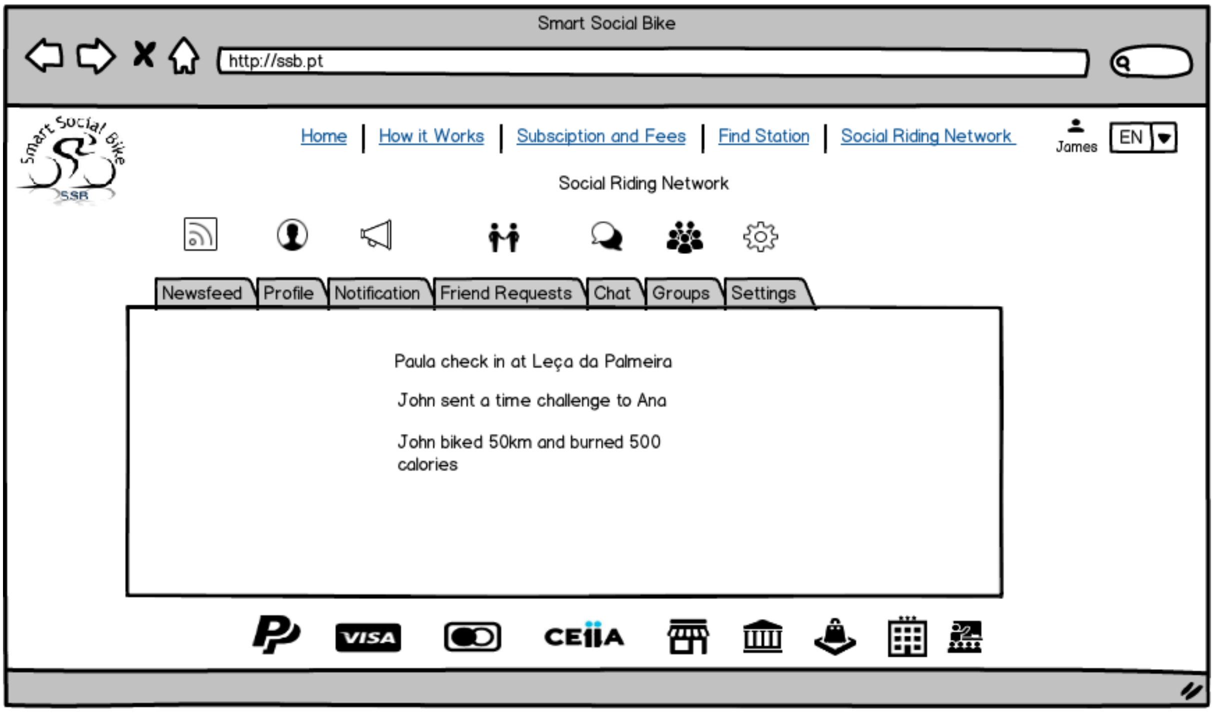

Smart Social Bike
http://ssb.pt
Home | How it Works | Subsciption and Fees | Find Station | Social Riding Network
James
EN
Subscription and Fees
SSB offers you a wide range of service scheme that suits you the best. Our prices result from intensive study of the market and we strive to offer you the best price for your ride.
Student
Type: Subsciption
Rate: *** euro
Select
Elder
Type: Subsciption
Rate: *** euro
Select
Tourist
Type: Subsciption
Rate: *** euro
Select
Annual Membership
Type: Subsciption
Rate: *** euro
Select
Monthly Membership
Type: Subsciption
Rate: *** euro
Select
Prepaid Hr/rate
Type: Pay as you Go
Rate: *** euro
Select
VISA
CEIIA


Smart Social Bike
http://ssb.pt
Home | How it Works | Subsciption and Fees | Find Station | Social Riding Network
James
EN
Register for Membership
Address
Postal Code
City
School / University
Continue


Smart Social Bike
http://ssb.pt
Home | How it Works | Subsciption and Fees | Find Station | Social Riding Network
James
EN
Membership Card
E-Card
Card
Pickup Point
James Student Scheme
Continue


Smart Social Bike
http://ssb.pt
Home | How it Works | Subsciption and Fees | Find Station | Social Riding Network
James
EN
Payment
Billing Country
Payment Type
Card or Account
Expiry Date
CVV/CID
Month
Year
Purchase


Smart Social Bike
http://ssb.pt
Home | How it Works | Subsciption and Fees | Find Station | Social Riding Network
James
EN
Find Station
List of Station
List of Operators
Information Kiosks
Partners


Smart Social Bike
http://ssb.pt
Smart Social Bike
SSB
Home | How it Works | Subsciption and Fees | Find Station | Social Riding Network
James
EN
Social Riding Network
Newsfeed
Profile
Notification
Friend Requests
Chat
Groups
Settings
Paula check in at Leça da Palmeira
John sent a time challenge to Ana
John biked 50km and burned 500 calories
VISA
CEiiA